This is a digital copy of a book that was preserved for generations on library shelves before it was carefully scanned by Google as part of a project to make the world's books discoverable online.

It has survived long enough for the copyright to expire and the book to enter the public domain. A public domain book is one that was never subject to copyright or whose legal copyright term has expired. Whether a book is in the public domain may vary country to country. Public domain books are our gateways to the past, representing a wealth of history, culture and knowledge that's often difficult to discover.

Marks, notations and other marginalia present in the original volume will appear in this file - a reminder of this book's long journey from the publisher to a library and finally to you.

Usage guidelines

Google is proud to partner with libraries to digitize public domain materials and make them widely accessible. Public domain books belong to the public and we are merely their custodians. Nevertheless, this work is expensive, so in order to keep providing this resource, we have taken steps to prevent abuse by commercial parties, including placing technical restrictions on automated querying.

We also ask that you:

+ *Make non-commercial use of the files* We designed Google Book Search for use by individuals, and we request that you use these files for personal, non-commercial purposes.

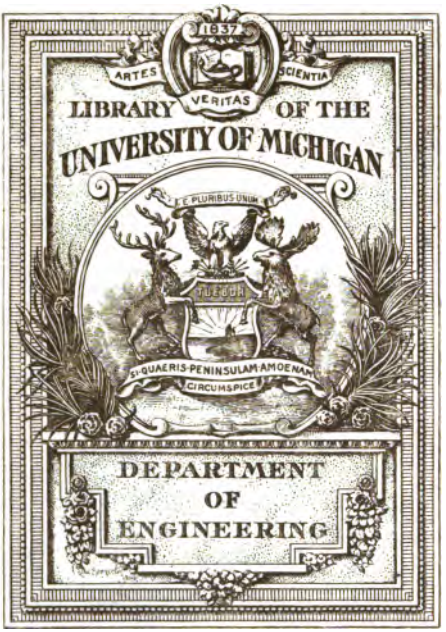
+ *Refrain from automated querying* Do not send automated queries of any sort to Google's system: If you are conducting research on machine translation, optical character recognition or other areas where access to a large amount of text is helpful, please contact us. We encourage the use of public domain materials for these purposes and may be able to help.

+ *Maintain attribution* The Google "watermark" you see on each file is essential for informing people about this project and helping them find additional materials through Google Book Search. Please do not remove it.

+ *Keep it legal* Whatever your use, remember that you are responsible for ensuring that what you are doing is legal. Do not assume that just because we believe a book is in the public domain for users in the United States, that the work is also in the public domain for users in other countries. Whether a book is still in copyright varies from country to country, and we can't offer guidance on whether any specific use of any specific book is allowed. Please do not assume that a book's appearance in Google Book Search means it can be used in any manner anywhere in the world. Copyright infringement liability can be quite severe.

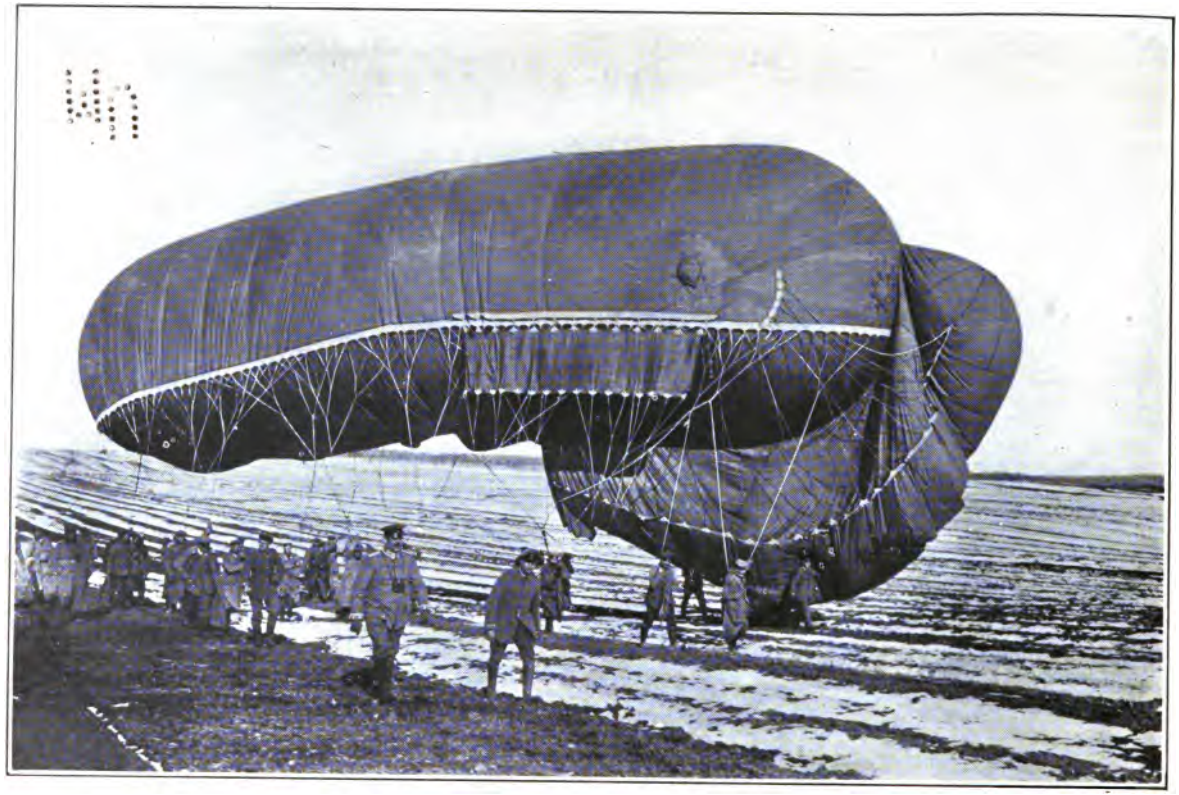
About Google Book Search

Google's mission is to organize the world's information and to make it universally accessible and useful. Google Book Search helps readers discover the world's books while helping authors and publishers reach new audiences. You can search through the full text of this book on the web at `http://books.google.com/`


1837
ARTES
VERITAS
SCIENTIA
LIBRARY OF THE
UNIVERSITY OF MICHIGAN
E PLURIBUS UNUM
TURGOR
SI QUAERIS PENINSULAM AMOENAM
CIRCUMSPICE
DEPARTMENT
OF
ENGINEERING

Engineering
Library
UG
640
.W64

Engineering
Library
UG
640
.W64



Frontispiece.

MILITARY OBSERVATION BALLOONS

(CAPTIVE AND FREE)

A COMPLETE TREATISE ON THEIR MANUFACTURE, EQUIPMENT, INSPECTION, AND HANDLING, WITH SPECIAL INSTRUCTIONS FOR THE TRAINING OF A FIELD BALLOON COMPANY

By
EMIL J. WIDMER

3 PLATES AND 38 ILLUSTRATIONS

NEW YORK
D. VAN NOSTRAND COMPANY
25 PARK PLACE
1917

fen sin
LIG
Ep40
.W64

Copyright, 1917, by
D. VAN NOSTRAND COMPANY

H 27718 M.M.
Release 2-11-41 Mgl

PUBLISHER'S NOTE

The value and importance of a volume covering the field of military balloons becomes obvious since keen students of the present world war have declared that the struggle will be won in the air. This book on the manufacture, equipment, inspection and handling of military observation balloons gives a complete survey of the field. It is based on the Balloon Manual of the German Army, including drill and equipment in use at the beginning of the war.

320691.

CONTENTS

CHAPTER		PAGE
I.	Description of a Kite Balloon	1
II.	Equipment of a Kite Balloon	16
III.	The Crew of a Kite Balloon, Officers and Men. The Inflation. Selection of the Anchoring Site. Preparation for Ascension. The Ascension	28
IV.	Training of the Field Balloon Company	44
V.	Inflating and Handling of a Kite Balloon during Maneuvers. Duties of the Balloon Squad. Duties of the Car Squad; of the Rope Squad. Balloon Transport, with Ascension Ropes; Transportation Ropes. Aid of Crew. High Transportation. Marching Order of the Balloon Transportation. Lifting over Obstacles. Deflation and Refilling of the Balloon	65
VI.	The Use of a Kite Balloon in Time of War	80
VII.	The Rules for Examining and Accepting the Cloth to be Used in the Manufature of a Kite Balloon. The Care of Material and Its Repair	94
VIII.	Materials Used	103
IX.	The Spherical Captive Balloon. Equipment; Inflation; Anchoring; Ascension	125
X.	The Free Balloon. Equipment. Preparation for Ascension. The Ascension	145

MILITARY OBSERVATION BALLOONS

CHAPTER I

Description of a Kite Balloon

THE kite balloon is a cylindrical gas bag with hemispherical ends, that sets itself, diagonally, like a kite, to the direction of the wind. The shape is maintained by the use of an air bag, or ballonet, which is situated inside the balloon proper, and at the rear or lower end. By means of an ingeniously arranged inlet and valve, air is automatically forced under pressure into the ballonet by the wind.

Suppose the balloon to be inclined to the horizontal at an angle of from 30° to 40°, and that a horizontal plane is taken which passes through the center point around which the hemispherical end is formed. The ballonet is now made by extending an inner skin down around the lower end of the bag, below the edges of this horizontal plane. It is securely sewed and cemented to the body of the balloon along its edges. It is therefore joined to both the cylindrical and hemispherical portions, forming a sort of an inner envelope, leaving, however, a space between the two into which the air can be driven by the wind. When the balloon is fully inflated, the inner envelope extends down-

ward and at its smallest possible distance from the outer envelope.

As soon as the balloon rises the gas expands, and the pressure on the envelope would increase to the bursting point if the gas were not allowed to escape. A valve, however, which is situated at the upper end of the balloon, is automatically opened by means of a chain, which extends from this valve to the center point on the inner envelope of the ballonet. This chain becomes taut and pulls the valve open when the airbag becomes empty. The careful adjustment of this chain is, therefore, a matter of great importance. As soon as the balloon begins to contract, air enters through the opening to the air bag, and the valves closes of its own accord.

In the ballonet a non-return valve prevents the air from escaping. The air is slightly compressed by the action of the gusts of wind, and this pressure extends to the gas and reacts upon the envelope. This is resisted by an internal pressure equal to that on the outside, and also by the static pressure acting on the top of the balloon. If there is a sufficiency of gas the envelope will always retain its shape. As soon as the gas expands and the pressure increases, the air is forced out of the air bag through a third non-return valve. This valve opens into an outside air bag, or steering bag, as it will be termed hereinafter. The wind therefore automatically supplies any deficiency which may arise.

As mentioned above, the balloon assumes an inclined position of about 30° or 40° to the horizontal. This position is affected through the method by which the cable is attached. It is held captive not by a rope connecting

to the basket, as in the case of cylindrical or pear-shaped balloons, but by a series of branch ropes which extend from the main cable to a girdle running around the body of the balloon, on a line parallel to and at a short distance below its longer axis. By this method of attachment the pull of the cable is distributed along the balloon and prevents any tendency to bend or buckle.

As it is important that the longer axis of the balloon should be kept pointing in the direction of the wind, a steering bag or rudder is provided. This is attached to the lower end of the gas bag and extends about half way around the hemispherical end and for several feet along the bottom of the cylindrical portion. The wind enters the steering bag through a non-return valve at its forward end and escapes through another valve at the back toward the top. These valves are so adjusted that there is always a slight excess of pressure in the steering bag over that of the outside atmosphere, but it must always be less than that in the ballonet itself, which discharges into it. The steering bag, having a slight excess of pressure in it, is kept extended and its effect on the entire balloon is similar to that of the large end of a weather vane, which always keeps the small end pointing into the wind. In order that these movements should not take place too suddenly, a tail is fastened on behind, and is secured to the main body of the balloon by branch ropes which extend to either side and fasten to a girdle. This tail consists of a long rope to which wind-catchers are fastened at certain intervals; these tail cups somewhat resemble inverted umbrellas. The wind, catching in these, tends to check any movement of the balloon, and a part of the kite effect

is lost. To neutralize this disadvantage, two sails are placed one on either side and toward the rear end of the balloon. In addition to offsetting the dragging-down effect of the tail, these sails increase the stability.

The basket is fastened to the girdle of the balloon by a separate suspension from that of the holding cable. A telephone connection is made with the ground by means of a wire which runs up inside of the main cable and, coming out of the upper end, runs in a long loop to the basket.

A valve-control rope extends from the basket up to the gas valve, so that in case a quick descent is desired the operator may allow the gas to escape by giving a strong tug on this rope. This valve, therefore, has two controls, one of which extends to and is fastened to the ballonet as previously described, and which opens the valve automatically, and one which runs to the basket, enabling the pilot to open the valve quickly.

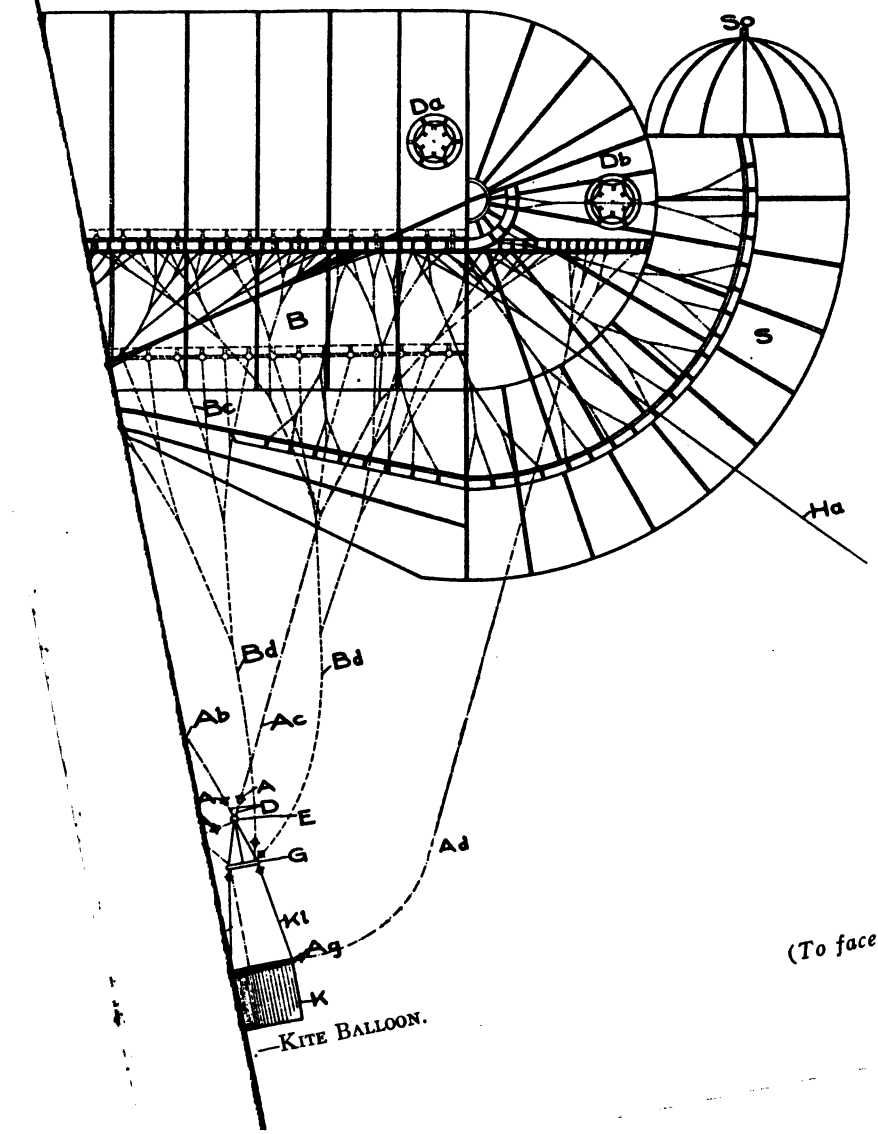
A further means for a quick descent is provided by the use of a ripping panel. This is nothing less than a patch on the gas bag which, by a strong pull on the rope running to the basket, can be ripped off, thus leaving a hole through which the gas rapidly escapes.

Experience shows that a captive balloon of the kite type maintains its position in the air with very little oscillation and that accurate observations are possible, and that maximum comfort is afforded to the observer.

Detailed Description

The kite consists of the envelope, rigging and the car.

Envelope. The envelope, which is cylindrical in shape and has hemispherical ends (Plate I), is made of yellow



—Kite Balloon.

(To face page 4)

rubberized diagonal cloth, and is put together by means of gores and segments.

It consists of the gas bag *G* (Figs. 3 and 4), the ballonet *B* (Figs. 3 and 4), and the steering ballonet *S* (Plate I, Figs. 3 and 4).

Gas Bag. The gas bag constitutes the greater part of the envelope and contains the gas for lifting the balloon. It is cylindrical in shape; the front end is bordered by the

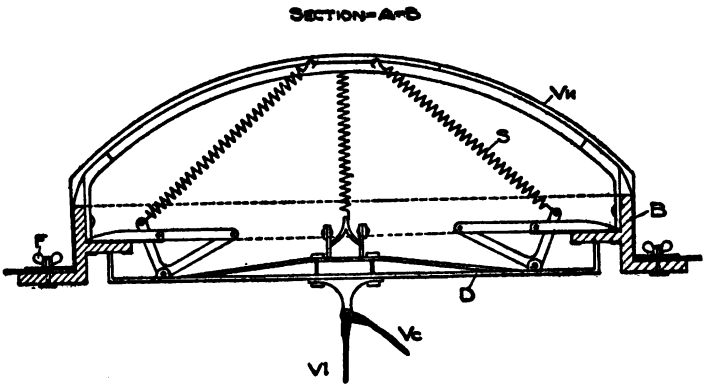


FIG. 1.

hemispherical nose and the rear by the ballonet wall which is sewed to the gas bag along *Bw* (Figs. 3 and 4).

Valve. The valve is set in the nose of the balloon. This valve serves for the escape of the gas and regulates the pressure; it is set to work either automatically or by a rope control from the car. It consists of the wooden valve body *B* (Fig. 1), the aluminum disk *D*, together with the valve cord *VI* (Plate I, Figs. 1, 3 and 4), the valve chain *Vc* (Figs. 1, 3 and 4), and the springs *S*, with the elbow

(Figs. 1 and 2), the butterfly screws *F*, with the washer and the two rubber packing rings.

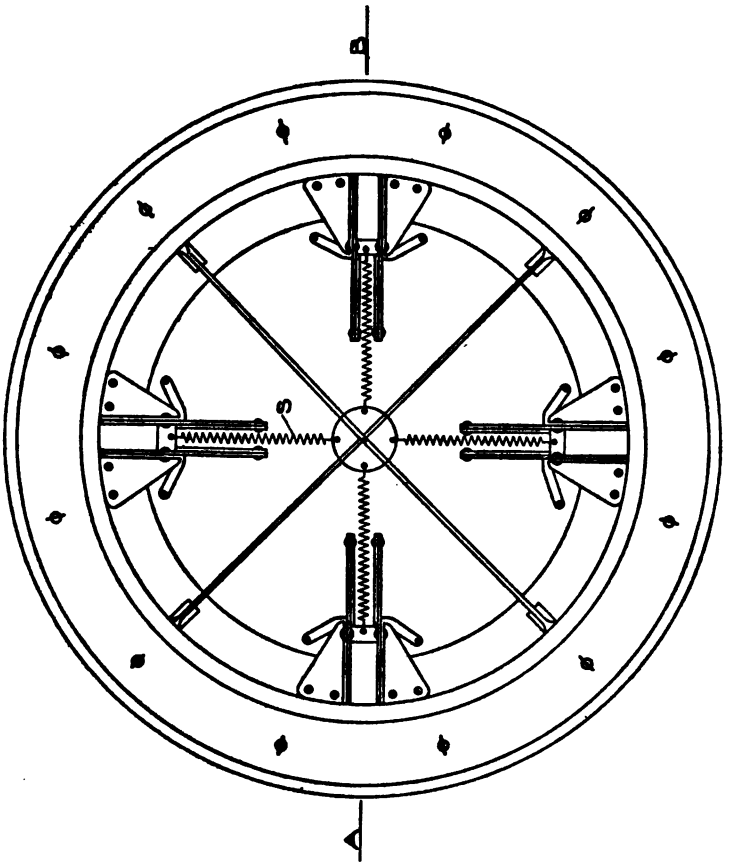


FIG. 2.—Valve.

The leather valve cup *Vk* (Fig. 1) serves as a protector to the valve and is to be taken off only when the balloon ascends.

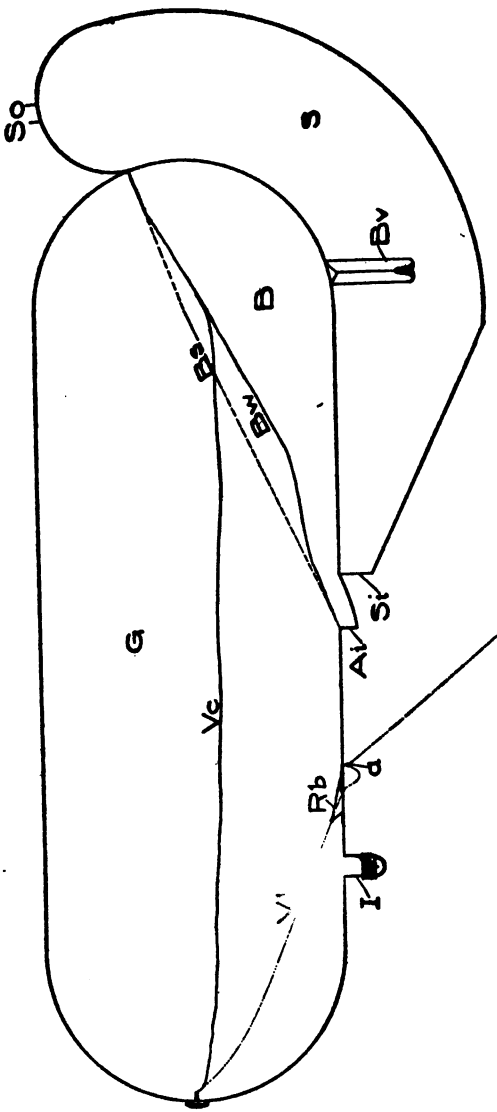


FIG. 3.—Kite Balloon.

Operating the Valve. By drawing in on the valve disk the valve opens and causes the spring to expand.

Valve Chain. The valve chain *Vc* (Figs. 1, 3 and 4) is made of steel, covered with light-weight cloth. It runs from the valve and, branching off near its rear end, connects the ballonet wall at three different points. When the gas bag is completely inflated it expands and the valve is opened automatically.

Valve Rope. The valve rope *VI* (Plate I, Figs. 1, 3 and 4) is of a yellow color and runs from the disk through an opening in the balloon. To prevent gas from leaking out around this rope at the balloon wall, a conical reversing bag *Rb* (Figs. 3 and 4) is provided. In order to prevent the opening of the valve by accident the rope is formed in a loop immediately outside of the conical reversing bag, and is fastened to the gas bag at point *a* (Figs. 3 and 4). This loop must be opened only when it is absolutely necessary. By giving a strong pull on the rope, from the car, the fastening at point *a* (Figs. 3 and 4) is torn off and the valve can then be pulled open.

Appendix. The appendix *I* (Plate I, Figs. 3 and 4) is in the shape of a cylindrical bag and is attached to the cylindrical part of the gas bag. It serves as a lead for the inflating tube into the balloon. After the balloon is inflated the lower end of the appendix is folded upward, and the whole is securely and tightly wound with a soft cord in order to prevent the gas from escaping.

Ballonet and Ballonet Wall. The ballonet wall separates the gas bag from the ballonet and is made of the same material as the envelope. It is sewed to the cylindrical and the rear hemispherical part of the balloon along

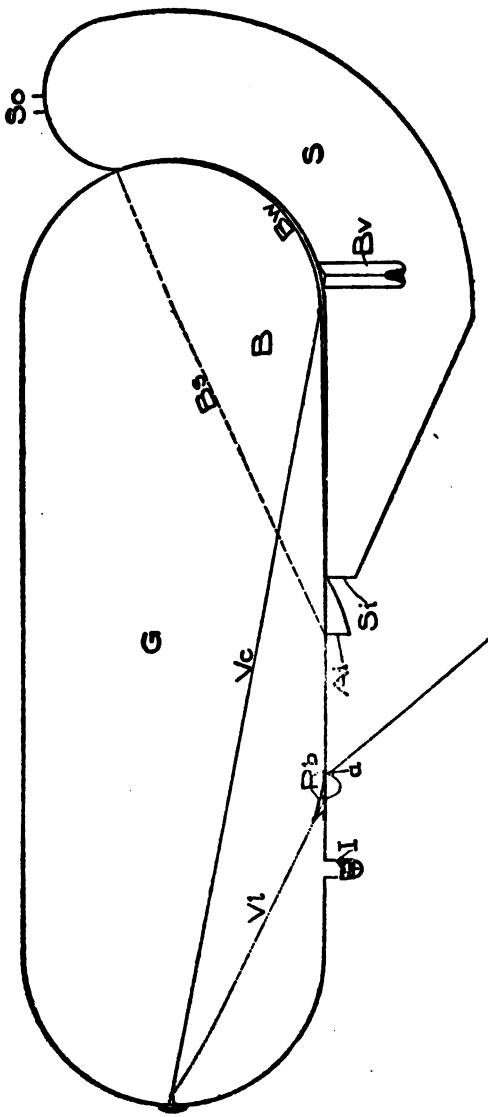


FIG. 4.—Kite Balloon.

the seam *Bs* (Figs. 3 and 4). When the balloon is entirely inflated the ballonet wall stands 4 inches away from the hemispherical end at the rear of the envelope.

a. The ballonet *B* (Figs. 3 and 4) is situated in the back lower part of the envelope and serves the purpose of holding the shape of the balloon in case the gas bag is not completely inflated and in the event of a wind. It is connected with the outside air by means of an air inlet *Si* (Plate I, Figs. 3 and 4).

b. This air inlet, the opening of which is funnel-shaped, has a flap valve in the inside made of cloth which allows the air to enter into the ballonet space. It also keeps the air from escaping through this opening.

c. When the gas bag is fully inflated the balloon is extended to its true shape. In order to retain this shape when there is an insufficiency of gas, the air which has been forced into the ballonet by the wind pushes the ballonet wall upward until the gas is under the same pressure as the air itself.

d. When the gas expands, in order that the pressure may not become too great on the envelope, a non-return valve *Bv* (Figs. 3 and 4), which is adjusted by an elastic band instead of springs, allows the air to escape from the ballonet into the steering bag.

Steering Bag. The steering bag *S* (Plate I, Figs. 3 and 4) is fastened to the rear end of the balloon and serves the purpose of holding it, by means of its steering effect, in the direction of the wind.

a. The steering bag is made of standard balloon cloth and is sewed on to the lower part of the gas bag. It is further held in place by means of rigging, which

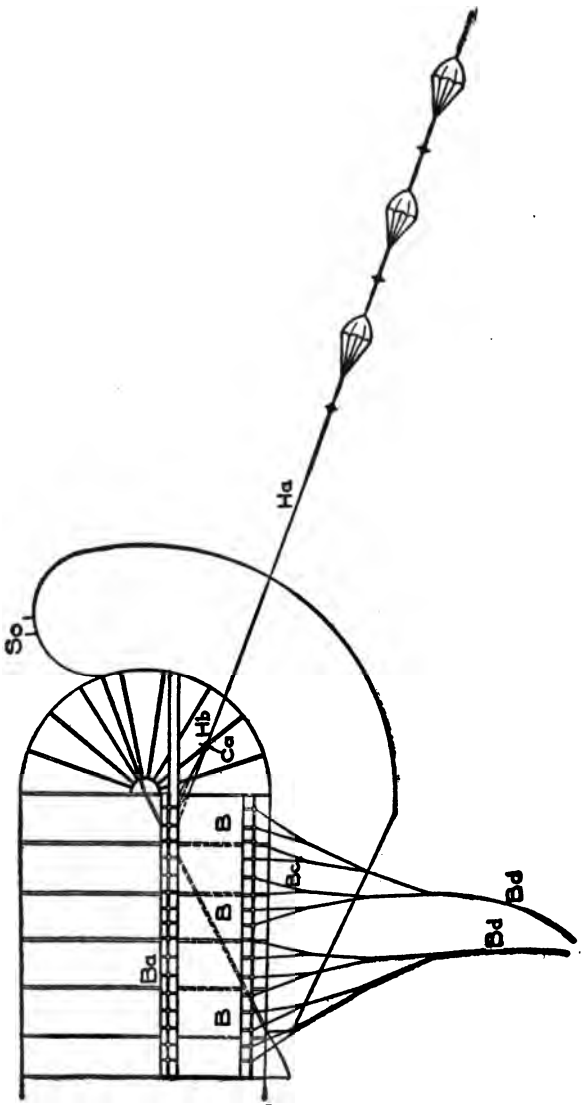


Fig. 5.—Steering Bag and Safety Valve.

extends from a steering bag band to the girdle of the gas bag.

b. At the fore end the steering bag inlet *Si* (Plate I, Figs. 3 and 4) allows the air to enter through a non-return flap valve.

c. On the back end of the steering bag near the top there is a low-pressure safety valve *So* (Plate I, Figs. 3, 4 and 5). This allows the air which is in the steering bag to escape if necessary.

Deflating Tube. For the purpose of deflating the gas bag and the ballonet, there are deflation tubes provided, *Da* and *Db* (Plate I), on the left side. Except when it is desired to deflate the balloon these openings must be kept securely closed and sealed to prevent gas leakage. This is accomplished by placing a rubber cap over the ends of the tubes and binding them on with soft cord.

Rigging. The rigging (Plate I) holds the mooring cable in place, holds the car suspended and supports and steadies the steering rudder to the body of the balloon. It consists of several rows of different-colored looped ropes. A series of loops are fastened to the balloon girdle. To each pair of these longer loops another and still longer loop is formed, and so on. The ends of these looped ropes are spliced around eyelets which allow the ropes to slide freely along the loop above.

Balloon Girdle. The girdle *Bg* (Plate I) is made of a strip of heavy, rubberized canvas, which is cemented and sewed along its upper edge to the envelope. Near its lower edge a series of equally spaced holes are provided for the connection of the suspension ropes. These holes are

formed by eyelets which are inserted in and securely sewed (by hand) to the girdle.

Rigging. The rigging can be divided into the following subdivisions:

a. The cable rigging (white ropes).
b. The car suspension (red ropes).
c. The steering bag rigging (blue ropes).

Cable Rigging. The cable rigging (Plate I) consists of the groups of looped ropes *Ct*, which are on both the left and the right sides of the balloon; the coupling rings *Cr*, the ropes *R*, the four toggle ropes *Tr*, the cross ropes *Rc*, with the pulley and shackle *Cs*.

The groups *Ct* consist of several rows of looped ropes, the lowest and largest of which run through the coupling rings *Cr*. The ropes *R* fasten to these coupling rings. To each of the two forward rings three ascension ropes are attached, while to each of the two rear rings but two ascension ropes are attached.

Fastened to the four ropes *R* at their lower end, by means of the toggles *T*, are the four toggle ropes *Tr*.

Running Cable. The running cable *Rc* fastens at each of its ends to two of the toggle ropes *Tr* by means of toggles. This running cable passes around the pulley *Cs*, which travels along this cable.

The pulley is fitted with a long shackle ring to which is fastened the rope clamp *Ml* of the mooring cable *C*. A ring *Rl*, for the attachment of the limiting rope *Lr*, and a steel ring *Rt* for the transportation ropes, is also fastened to the shackle ring.

The travel of the pulley forward along the running rope

is so limited by the limiting rope *Lr* that the balloon retains its kite position.

The ropes *R* and *Tr* are constructed with a hemp center, which is covered by steel rope strands, which in turn are covered by manila strands. The running cable is of steel.

Car Suspension. The car ropes, Plate I, serves as a suspension for the car and consists of five red main lines, which are fastened with a number of rows of loops underneath the white rigging to the girdle.

The front line *Aa*, the two middle lines *Ab*, and the two rear lines *Ac* are constructed similarly to the cable tackling group, each one ending in a rope eyelet *A*, into which the toggles of the ropes *D* running from the ring *E* are fastened.

The four adjusting ropes *Ad* also belong to the car suspension.

Steering-bag Rigging. The steering-bag rigging is made of blue ropes, and serves as a support for the steering bag. It is fastened to the balloon girdle and its curved continuation and extends to a girdle which is sewed onto the steering bag. It is formed by several rows of looped ropes.

When the steering bag is fully inflated all of these ropes must be tied.

Sails. The sails *B*, Plate I (Fig. 5), are made of rectangular pieces of cloth, one of the long sides of which is fastened by means of lacing to the belt *Ba* (Fig. 5), which is sewed along the rear half of the cylindrical part of the gas bag. They must be taken off when needing repair. At the outer side of the sails, leading out from the sixteen loop ropes *Bc*, are the two sail lines *Bd*, which are

fastened to small toggle ropes of the ring *G* by means of eyelets.

Tail. The tail *Ha* consists of a tail line and several detachable tail-cups. It is fastened to the front coupling rings *Ca* by the descending lines on both sides of the balloon, by means of a toggle *Hb*.

Car. The car *K* is woven willow and bamboo, and is pierced on the sides.

a. Two ropes *Kl* lead from each corner of the car and are fastened to one eyelet. This eyelet fastens to the ring *G* by means of the toggle ropes.

b. Besides this, the car is kept from swinging by four adjustable ropes *Ad*, Plate I, which are fastened to the eyelets *Ag* at the corners of the car.

Car Equipment. The equipment of the car may be divided into the following:

The balloon loading ring and its attachments.

The car observing station and telephone connection.

Two pockets for maps and instruments; to contain an aneroid, two field glasses, a clasp knife, barometer, two flags—one red and one white one for hand signaling—or disk signals, and a field copying book.

Ten tin cases for inclosing military reports, which have flags tied to them by means of linen cord.

The signal code.

Life preservers.

CHAPTER II

Equipment of a Kite Balloon

THE equipment necessary for the ascent and the maneuvering of a kite type captive balloon consists of :

Mooring cable and drum;
Pulleys;
Ascension ropes;
Traction ropes;
Tree ropes;
Rope clamps;
S hooks.

Mooring Cable. The mooring cable is an extra-strong steel cable, about $\frac{5}{16}$ inch in diameter. Two insulated wires running through the center are used as conductors for the telephone line. The mooring cable is V-shaped at its end. The cable clamp rings run through the shackle ring which is connected to the shackle by a removable pin.

At the V-shaped end of the cable there is an insulated double-circuit connection. Wires *M* (Plate I) from here to the balloon car form the continuation of the telephone line. One of the wires is connected to the mooring cable, which acts as a ground wire.

The telephone connection at the car station is made through batteries and a switchboard.

Rope Drum. The mooring cable is rolled up on a transportable cable drum (Figs. 6 and 7). The cable drum con-

sists of a drum *a*, with a shaft *b*, the handwheel *c*, the brake band *d*, the telephone plugs *e*1 and *e*2, and the frame *g*, with the wooden handle *h*. The two terminals *e*1 and *e*2 are the

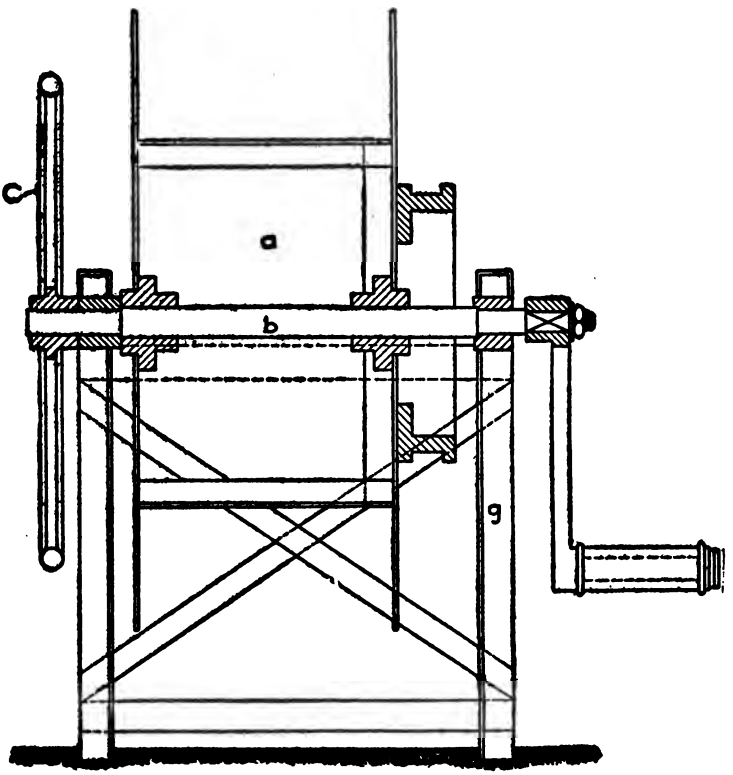


FIG. 6.—Cable Drum.

line terminals of the cable drum, the terminal *e*1 being insulated from the metal part of the drum frame by a hard-rubber cylinder *i*, by means of which a short circuit with the terminal is prevented.

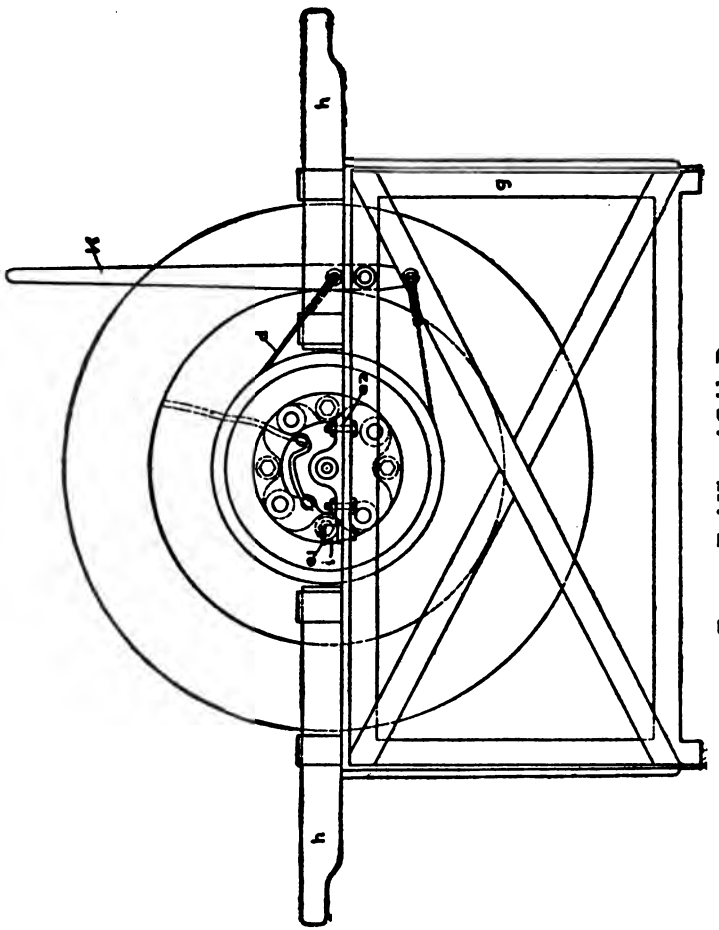


FIG. 7.—End View of Cable Drum.

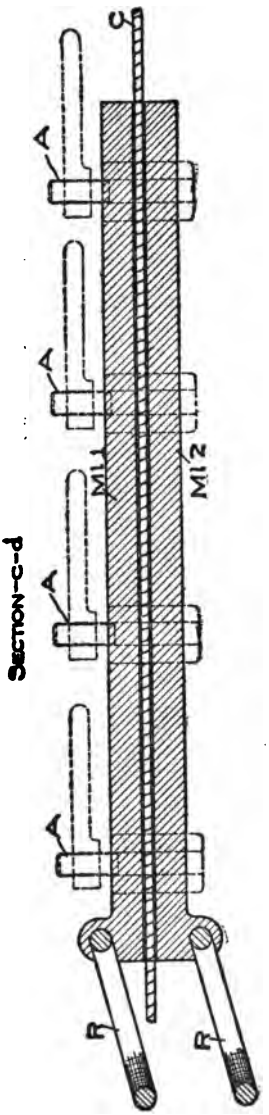


FIG. 8.—Cable Clamp

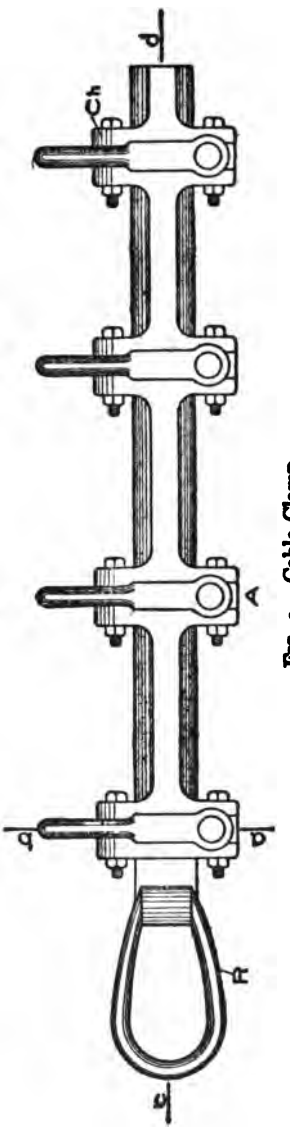


FIG. 9.—Cable Clamp.

The terminal *e1* serves as a connection to the telephone central, while the terminal *e2* is a connection to the metal part of the drum and then to the mooring cable.

The mooring cable is rolled or unrolled from the drum by turning the handwheel *C*. The friction brake band *d* is applied by pulling on the lever *k*.

Cable Clamp. The cable clamp serves to hold the mooring rope in place. It consists of two fitted clamps *Ml1* and *Ml2* (Figs. 8 and 9), between which the mooring rope *C*

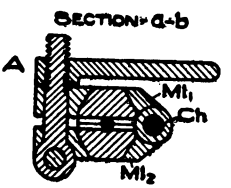


FIG. 10.

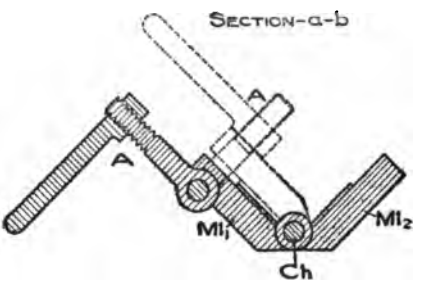


FIG. 11.

Cable Clamp Details.

is closely pressed by means of several screw bolts *A*. This prevents the ropes from slipping out. The tightening of the screw bolts must be done by hand only.

The clamps *Ml1* and *Ml2* (Figs. 8 and 9) have rings *R* at one end and are connected to each other by means of hinged clips *ch* (Figs. 9 and 10). The clamp is fastened with a tree rope to some firm object.

Tree Rope. The tree rope is a manila rope which is fastened at its upper end by means of a ring to the cable clamp rings; its lower end, which is spliced around a thim-

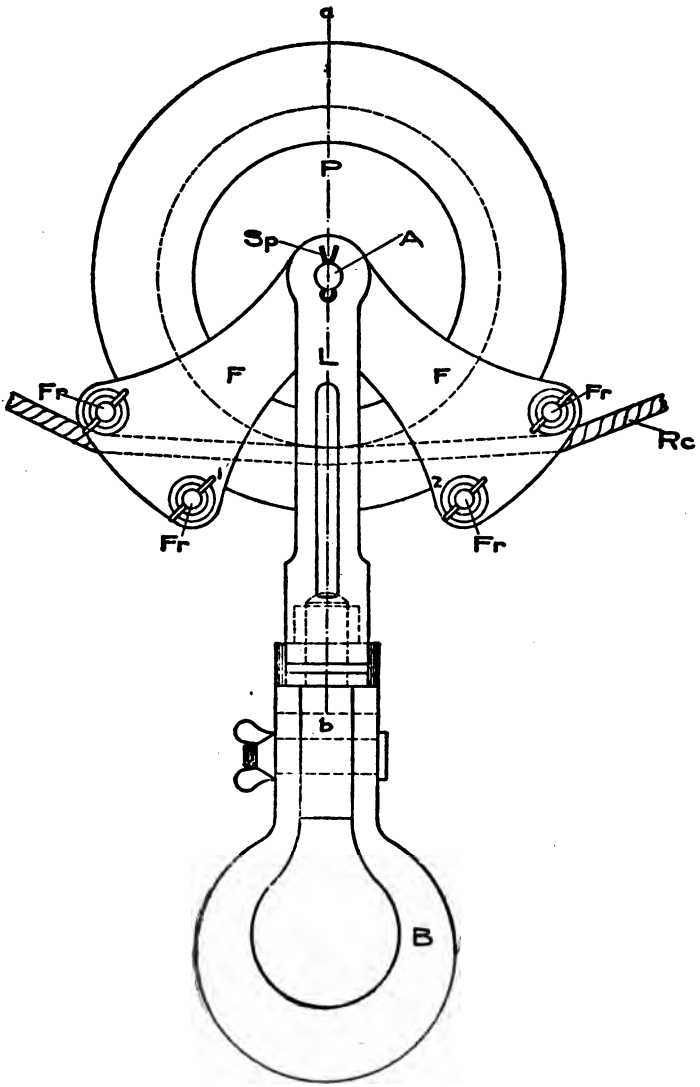


FIG. 12.—Rope Pulley.

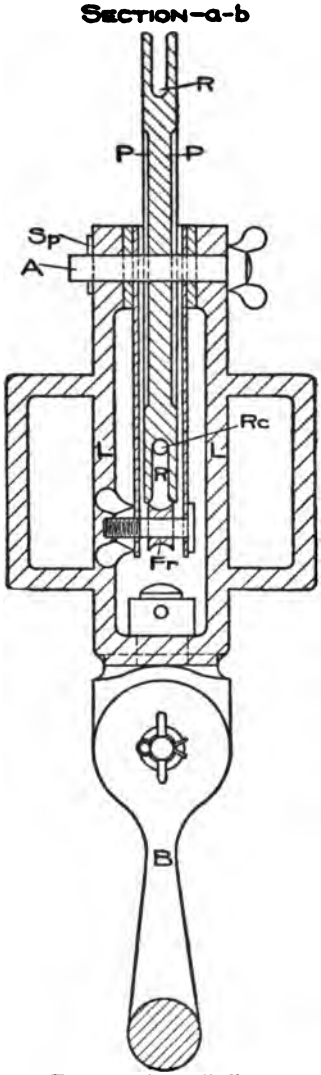


FIG. 13.—Rope Pulley.

ble, is fastened to an S hook. When the balloon is near the ground and it is desired to anchor it, this rope is passed around a tree or any other firm object, and the S hook is fastened to a snap hook, which is attached to a rope at some little distance from its lower end.

Rope Pulley. The rope pulley is made of steel with a bronze groove *R* (Figs. 12 and 13). This groove holds the running cable *Rc* on the pulley. The cable is prevented from slipping out by the guide arms *F*.

The guide arms are fastened to the removable pulley, through which the running cable must be passed. To do this the pin *A* is removed from the shackle arms *L*, followed by the two rollers *Fr*1 and *Fr*2. The rope is then placed so that it rests in the pulley groove *R* and against the remaining two small rollers *Fr*. The shackle arms *L* are then slipped back in place, the pin

A fastened in place by the cotter *Sp*, and the two rollers *Fr1* and *Fr2* restored.

Ascension Ropes. The ascension ropes are 35 feet long and have toggles at one end for fastening to the coupling ring *Cr*, Plate I.

Pulley Ropes. The pulley rope, together with the movable pulley, serves for descending and ascending, and consists of one rope on which there is either fastened a wooden toggle or a tension belt. Six lines meet at this belt or toggle and terminate in hauling belts. The belts are to be placed from the right shoulder to the left hip. The belt must never be placed around the hip.

Transport. For transportation the following are necessary: the transport line, the plummet, two pairs climbing spurs, one tool chest, the three-pieced lifting fork, the three-pieced ladder, the rope pulley and clamp, the traction ropes, and the tree rope.

The transport ropes are from 80 to 160 feet long.

The plummet serves for throwing the ropes over obstacles. It consists of a cord to one end of which a weight is fastened.

Anchoring Materials. The anchoring of a kite balloon is done by means of three-pieced anchorage belts, sand bags, a rectangular balloon blanket, stakes and mallets. The anchorage belts consist of broad strips of canvas on whose ends there are four ropes fastened into metal eyelets. They are thrown over the balloon which lies on the blanket by means of the plummet, and are fastened by their ropes to stakes or some firm object and serve to hold the balloon on the ground. The balloon blanket is

for the balloon to rest upon when it is held to the ground, and to protect it from dirt and moisture.

The stakes are reinforced with iron points, and with strong iron rings near the head.

The Aneroid. The aneroid is used for determining the elevation of the balloon, showing the rise and fall at any time while the balloon is in the air.

It consists of a very thin vacuum-walled metal box which is slightly bent by the changing air pressure. This bending actuates an indicator by means of a lever arrangement.

Field Glasses. In the equipment of the balloon are two sets of field glasses. One has a strong lens for distant vision and the other a magnifying lens for discerning objects near by.

Wind Gauge. The wind gauge is used to determine the velocity of the wind both before and during the period that the balloon is in the air. It is supplied with a propeller which is set in motion by the wind, and which impels a series of gears which in turn operate an indicator.

To measure the velocity of the wind the instrument must be placed so that the wind blows directly on the propeller. The position of the indicator on the scale is first read, then for a certain number of seconds (which should not be less than ten) the wind is allowed to turn the propeller, after which a second reading is taken. By dividing the difference of the two readings by the number of seconds that the propeller has been allowed to turn, and by allowing for any inaccuracy of the instrument, the velocity is determined.

The instrument is fitted with a lever arrangement through which the propeller and the indicator can be

disconnected. This allows the indicator hand to be turned back and permits of further readings.

Other Requirements

Carriers. The tin cases serve as carriers for written reports, and are dropped from the car station to the ground. The cases have covers with locks and different-colored linen flags so fastened that they attract attention when thrown from the car.

Nurse Bags. The equipment of the balloon includes several bags of about 3500 cubic feet capacity. These bags may be either spherical or cylindrical in shape, and are used for storing reserve gas. When the weather conditions make it difficult to inflate the balloon directly from the tanks on the ground, these bags are connected to the balloon and the gas is forced into it.

Ballast Bags. The ballast bags are filled with 35 pounds of sand, and are used to weigh down the balloon when at anchor. They are made of canvas and are provided with hooks. In hanging the sand bags the point of the hook must never be turned toward the balloon.

Telephone Connection. For the telephone service between the balloon observer and the ground station, and with the superior officer, there are three stations, the car station and the two ground stations, with 1300 feet of telephone wire.

The microphone telephones of the balloon divisions are arranged the same way as the telegraph of the cavalry.

The microphone case has a receiver, connection wires, and plugs. The connection between the land station and the car station is obtained on one end by the insulated

telephone cable of the mooring rope and on the other end through the steel mooring cable and the rope drum itself.

Ground Station. The establishment of the first ground station is obtained through a circuit between the telephone and the microphone case.

The second ground station can be connected either in the same circuit of the car station, or by replacing the wires running from the drum to the telephone with a ground conductor. This is obtained by means of a non-insulated wire, running from the iron binding screw to the conductor stuck in the earth (a sword or bayonet), and in that way connects the free line terminal of the telephone with the ground. When the last method of connection (of the second station) is to be considered, the cable drum and the non-insulated binding screw offer a better circuit when the ground is damp.

Optical Signals. The equipment of visible signals by day consists of a red and a white hand-signaling flag; at night an electrical signaling apparatus is used.

Electrical Signaling Apparatus. The electrical signaling apparatus consists of a battery case, an electric lamp, and the circuit cables.

The battery furnishes the current for the lamp. It consists of a hard-rubber case with a cover, which is divided into six cells and placed in a small wooden box.

Six pairs of electrodes are fastened onto the cover in conformity with the cells of the rubber case.

The positive electrode of every element consists of two carbon plates, which are separated by a small space.

The negative electrode of every element consists of a

rough zinc plate covered with linen, which fills in the space between the carbon plates.

The carbon electrodes of a cell are connected with the zinc electrode of the next element by means of a brass piece and two binding screws. By this arrangement we have a free positive and negative electrode, and make thereby the battery poles which are connected with the circuit cable of the lamp by means of its binding screws and wire. The fluid for charging a battery consists of a composition of one part double strength chromate of potassium, three parts water and one part muriatic acid.

The cells are to be filled a little over half full, and after the electrodes have been installed the battery is in working order. The connecting wires of the lamp are fastened in the free terminal of the battery. To light the lamp a button is pressed with the resultant flow of current.

In operating the signaling apparatus, it is essential that the various screws and plates be kept clean and held firmly in place. Also the linen covers of the zinc plates must not be torn or injured in any way, as they supply the necessary insulation for zinc and carbon.

When the zinc plates have become much worn through long service they should be replaced by new ones covered with prepared linen.

The lamp will burn eight hours from a battery charge of 32 quarts of solution.

CHAPTER III

The Crew of a Kite Balloon, Officers and Men. The Inflation. Selection of the Anchoring Site. Preparation for Ascension. The Ascension.

Assigning of Officers and Men. The commander of the balloon squad assigns the officers according to his own judgment.

The balloon observer is stationed in the car and reports the outlook.

The pilot with the car squad supervises the installation and working of the telephone and the other apparatus. He must assist the observer.

The officer in charge directs the work of the balloon; that is, he sees to the couplings, the ascension, transporting, anchorage, etc.

The commander of the ground station supervises the laying out and anchoring of the mooring cable and the establishment of the ground station and is responsible for the maintenance of service.

The commander of the next station lays the conductor and supervises it. A petty officer may be made commander of this station. The officers in reserve can be appointed for service at the ground station or for mapping out the next station.

The Crew. There are at least forty-eight men required for a kite balloon. They are divided into eight squads

which consist of five men and one leader each. If there are more then forty-eight men the rest form a reserve group.

The squads 1 to 6 are detailed for the balloon, squad 7 for the car, and squad 8 for the ropes. The men in a squad are numbered 1 to 6, the leader being No. 1.

The balloon squads are used for the balloon only. Those who have the uneven numbers are placed on the left side and those having the even numbers are on the right. To determine the left or right side of a balloon one looks from the car toward the safety valve.

The duties of the car squad are the equipment of the car, its fastening, the fastening of the mooring cable to the balloon, and the connection of the telephone station in the car.

The rope squad must lay out the mooring cable and fasten it and establish a ground station.

The reserves help to lay out the mooring rope, and in case it is necessary, assist in constructing the telephone circuit to the second station and do guard duty when transporting the balloon, and are called upon to help out whenever necessary.

Inflation of a Kite Balloon

Examination. An officer must examine every balloon and when he has pronounced the envelope to be faultless and decided that the rigging and valve are in perfect order, the balloon is inflated.

Inflating Gas. A kite balloon is usually inflated with hydrogen. Any balloon which has a capacity of over 35,000 cubic feet can also be inflated with illuminating gas.

Place of Inflation. The inflating of a balloon should

be done out of sight and beyond the gun range of the enemy, and in a place shielded from the wind.

The car group must clear the space of all pointed stones, glass and other objects which might puncture the balloon and then lay the blanket upon that clearing. The carrying and spreading out of the balloon must be done by the balloon squad, during which time the rope squad must fill the sand bags.

Gas Squad. The men with the exception of those classed as tradesmen are divided into groups of fourteen to sixteen men each. The division of officers and the relieving men are regulated.

Preparation. The balloon is placed upon the rectangular blanket with the valve in the direction of the wind, and is spread out so that the belt is on the circumference and that the cloth of the envelope is smooth. As the belt runs under the equator it is necessary to make several vertical folds in the upper material. The sand bags are to be evenly distributed around the balloon and are to be attached to the ropes on the belt.

The valve chain is so placed that it lies perfectly straight and the valve rope lies free.

The valve must be examined; then the tin pipe is placed in the appendix and is tied on (gas tight), by means of a soft cord; the other end is connected in like manner with the filling hose of the gas apparatus when the gas is let in.

Completed Inflation. The inflation is completed when the valve opens automatically.

After the inflation is completed the tin pipe is removed from the appendix and the latter is securely tied up so as to be gas tight. It must be equipped with a safety cap.

The Selection of the Anchoring Site

Site. The anchoring place should be out of the range of the firing of the enemy and also out of their sight, and shielded from the wind. The best places are roomy hollows, quarries, unused highways, and behind houses and groups of trees. On a flat, unprotected plain, wagons can be placed on the windward side to give the necessary protection from the wind. Afterward, the earth is thrown up by trenching on that side in the direction of the wind. This embankment is formed in the shape of the balloon. The use of improvised balloon sheds and wooden walls on the windward side is of advantage.

The preparation of an anchoring place is the same as that of an inflation place. The balloon is to be anchored on the blanket in an uncoupled condition, fastened and weighed down by sand bags.

Balloon Watch. A balloon watch must always be ready at the anchoring place, and have mallets, stakes, and ropes at hand.

Under normal weather conditions and when the balloon is anchored near its storing place, the watch should consist of at least one commander and three men, and they must serve as a day and night guard.

In unpleasant weather and when the balloon is far away from its storing place the number of men is increased according to the judgment of the commander of the balloon squad and an officer must stay with the balloon at all such times.

The watch commander should see that the following points are covered:

Under rising temperature and corresponding gas expansion the holding lines must be slackened. Under falling temperature the same lines must be tightened. It is best to dry the rope first in case it has become wet.

In anchoring during an increasing wind, the anchorage is to be strengthened accordingly. Should the wind become so severe as to threaten to tear the balloon from the moorings, the officer at the balloon must as a last resort order the balloon to be cut open.

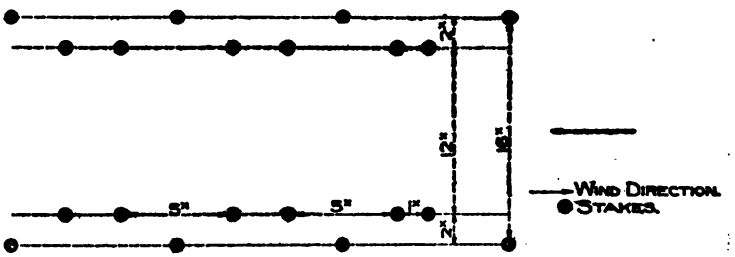


FIG. 14.—Layout for Mooring.

This work is done by those men who are not at a given post, or the relief squad can be called upon to do it.

Salutes are not given during the work, but after its completion.

Anchoring. The anchoring of a kite balloon is divided as follows:

1. The laying out of the mooring place is done by the reserve squad by means of two mallets and twenty stakes (Fig. 14).

2. Stretching the rectangular blanket with its long side toward the direction of the wind, or in a direction best suited for the conditions of the place.

3. Transporting the balloon with the valve in the direction of the wind onto the blanket, throwing over the anchoring bands (by means of the plummet) by the car groups.

4. Fastening the anchor bands to the stakes, placing the valve cap on the valve, arranging the tackling and weighing down the balloon with sand bags, by the car squad and leaders (No. 1) of the balloon squad.

5. Arranging the mooring rope by the rope squad, the car by the car squad, the equipment of the car by the reserve squad (car squad).

Preparation for the Ascension of a Kite Balloon

Preparation of Equipment. During the inflation of the balloon, before the division of the men, the officer, together with those leaders No. 1 of the car and rope squads, must see that a hand wagon or a rack wagon is loaded in the following manner:

The car squad must see that it has, for the equipment of the car, a cross rope with a running pulley, tow rope, 8 tail cups, 1 roll of the traction rope, 1 rope pulley, 2 red and 2 white hand flag signals.

The rope squad must have 1 complete mooring rope, 3 rope clamps, 3 tree ropes, 2 rope pulleys, 1 completely packed telephone-box equipment, 3 receivers for microphone telephone case, 4 drums with 3300 feet telephone wire, 3 conductors, 1 telephone wire drum frame.

If the place of ascension is distant or in case a rack wagon or a farm wagon must be packed, the blanket, the anchoring material (20 stakes, 50 sand bags, 3 anchor bands, 4 mallets),—in fact a complete set of tools and a hand wagon—must be taken along.

Activity. The preparation for ascension of an anchored kite balloon consists of:

1. The lifting of the moorings.
2. Transporting the car to the place of ascension; equipment of the car station.
3. Laying out the cable clamp of the mooring cable and equipment of the telephone station.
4. Transporting the balloon to the place of ascension.
5. The coupling together.

Arrangement of the Crew. Upon the command of "Report for Service" all men step in front of the balloon in the manner shown in Fig. 15. The oldest petty officer fills in the missing numbers with men taken from the reserve squads and gives the report.

The officers are assembled with the commanders of the various squads.

In order to divide the men, the command "To the balloon" is given, whereupon the squads take their places as shown in Fig. 15 and the men seize the rigging ropes.

Balloon Squad. When the balloon is to be transported for a considerable distance, the officer orders the men of squad No. 1 and squad No. 2 to fasten five sand bags along each side of the balloon. These bags are distributed at equal distances along the long sides, and remain so fastened until the site of ascension is reached. Upon command of the officer the same men remove the bags.

Car and Rope Squad. The command for the forward march of the car and rope squads is given before that of "report for duty." They march in a body to the destined place and take charge of and push the packed hand or

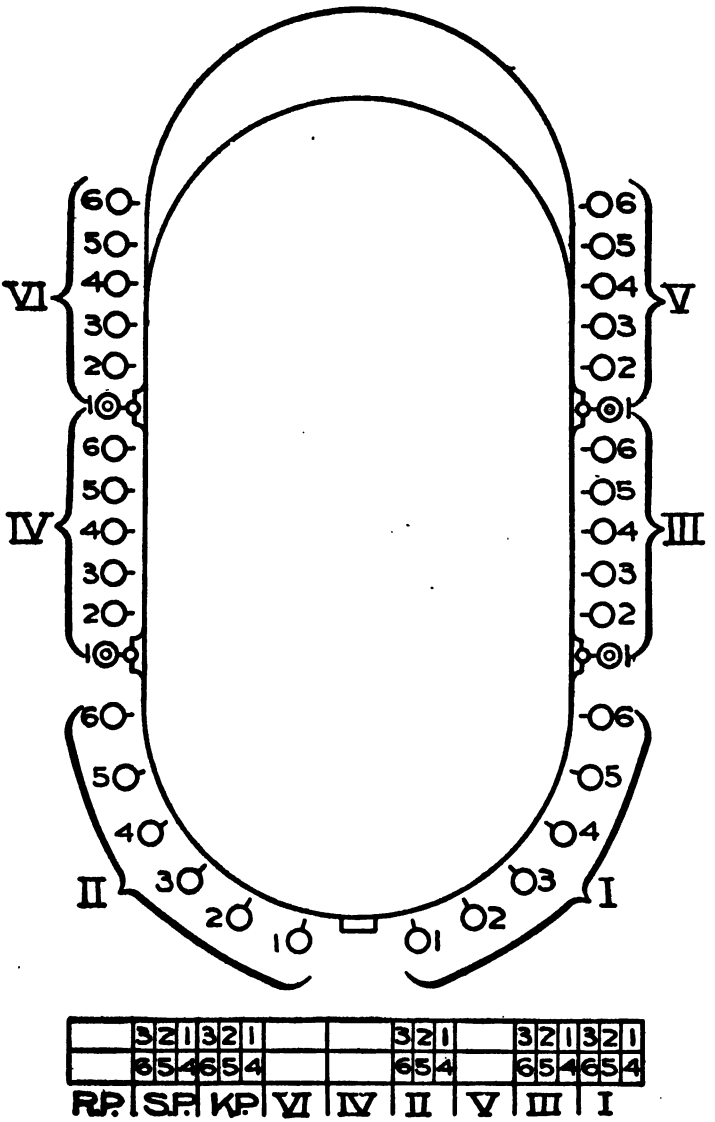


FIG. 15.—Layout for Ascent and Arrangement of Crew.

other wagons to the place of ascension. They are then ready for the commands of the officer for the preparation.

Ascension of a Kite Balloon

The Car Squad. On arrival at the place of ascension the material for the balloon squad is unloaded. The car is placed with the long side in the direction of the wind. Nos. 1 and 2 take the cross ropes and the ascension ropes out of the car, Nos. 3 and 4 the rope pulley and six coils of pulley lines. Nos. 5 and 6 take the tow line and the tail cups and place them as shown on Fig. 16. No. 4 is detailed to fasten the mooring cable in the cable clamp and the cable clamp to the ring of the pulley shackle.

The Rope Squad. The mooring cable should, when possible, lie along the ground in a straight line and in the direction of the wind. If this is impracticable it should be either stretched out in a line as straight as possible or else wound around some firm object. The laying out of the cable can be accomplished by one of the following three methods:

1. No. 4 of squad No. 8 holds the cable clamp end of the cable, standing at the ascension site, and the cable is unwound from the drum by transporting it by the hand wagon from the ascending to the anchoring site.

2. The rope drum is placed at the anchoring site, and No. 4 of squad No. 8, assisted by three men of the rope reserve squad, carries the cable clamp end to the ascension site.

3. This method is the same as the first except that the drum is carried by the reserve squad instead of being

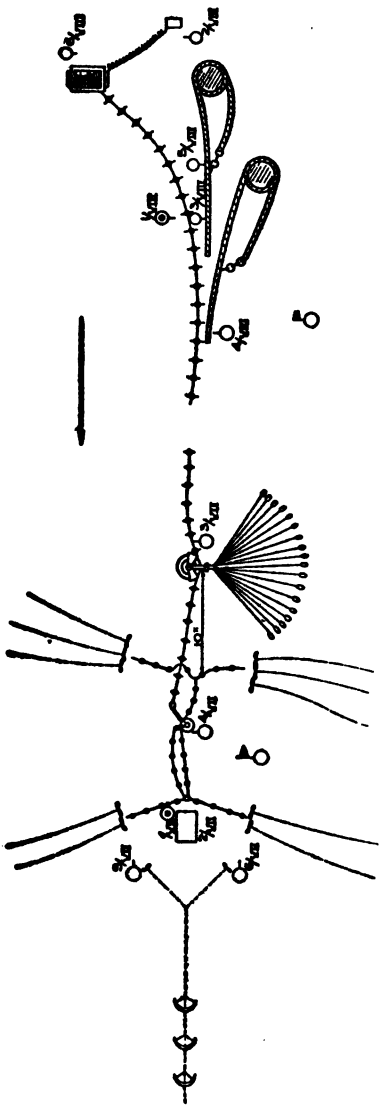


FIG. 16.—Ascension of Kite Balloon by Means of a Movable Pulley.

transported on the hand wagon. This third method is rarely used.

Whichever method is used, No. 4 of squad No. 8 gives the cable clamp to No. 4 of squad No. 7 immediately after the cable is laid out.

The Ascension by Means of a Movable Pulley. (Fig. 16.) Under the supervision of the commander of the ground station the following preparation for ascension with a movable pulley must be made:

Nos. 1, 5 and 6 fasten the tree rope to some indicated firm object, such as a tree, or the back axle of the gas wagon.

The tree rope is to be wrapped around the object several times until the strain of the balloon falls upon the long sling of the rope, which has an iron ring on it. The end of the rope is to be fastened for safety to this iron ring by means of a snap hook. The short sling of the rope has no strain on it.

Nos. 3 and 4 lay the leather rope lock in the direction of the mooring cable. The clamp is then closed and the screws tightened. The ring is connected by means of the S hook to the tree rope. This is done in such a manner that the S hook has the mooring cable beneath it.

Nos. 1 and 3 attend to the installation of the ground station.

When the mooring cable is ready for ascension and the telephone connections are made, the commander of the ground station reports to the commander of the car station, "Ascension Clear."

Stationary Pulley. (Fig. 17.) For preparation for ascension with the stationary pulley all numbers march with

the hand wagon to the ground station. From 50 to 80 meters of rope are laid out. Two tree ropes are generally used, one for the pulley and one for the clamp. The rope drum is about 50 to 100 meters from the rigid pulley. The rigid pulley is handled by No. 3 of Squad No. 7. He adjusts it and does all other necessary work. The rope lock of the mooring cable is handled by No. 4 of Squad No. 7,

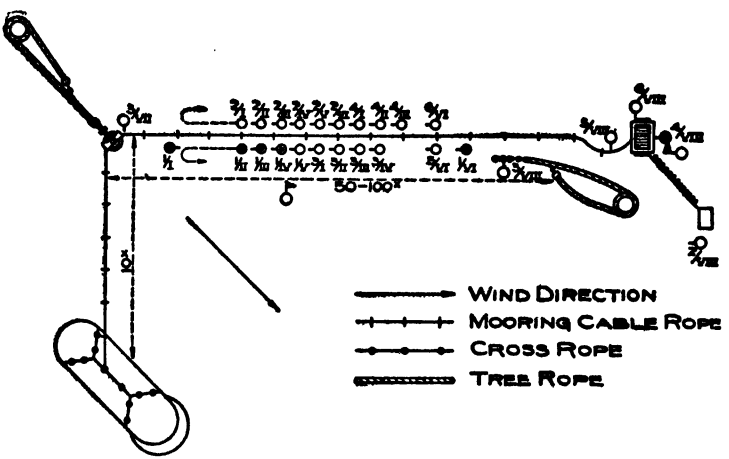


FIG. 17.—Ascension of a Kite Balloon by Means of a Stationary Pulley.

and is held ready about 6 to 10 meters from the stationary pulley until the arrival of the balloon. The preparations are the same as those for the movable pulley.

No. 6 mans the handle of the rope drum.

No. 5 mans the brake band of the rope drum.

Nos. 3 and 4 lay the clamp ready and clamp at the command.

When a strong wind is blowing the mooring cable is laid back of the clamp and is wrapped around a tree or

other solid anchorage. The cable can be doubled between the rope clamp and the drum and then wrapped around a firm object. The rope loop is held with a stake. Two tree ropes and two clamps are used. The second clamp is handled by No. 4 of squad No. 8. If necessary four men from the reserve squad can be called upon to prepare for ascension. These men, under the supervision of an officer, handle all the " by-connections." One man takes charge of the telephone case and receivers. Another man follows at a distance of 100 meters with the wire and unreels it. Still another man follows at a distance of 10 meters with insulation materials and testing instruments. His work is to test the connections and repair any trouble. A fourth man with a tree fork and climbing spurs places the wire in the trees. This line has to be connected to the ground station while this work is in progress. If it is necessary to cross roads, a guard must be stationed at such points.

Coupling. (Fig. 18.) After the balloon is over the car, and the coupling ring over the toggle of the cross rope, Nos. 5 and 6 of the car squad couple the tail line at the command, " Ready, Couple for ascension."

The balloon then ascends until the coupling rings are breast high. If sand bags have been hooked on they are taken off at the command " Uncouple."

Balloon Squad. (Fig. 18.) Nos. 1 of squads 3 and 4 couple the forward toggles to the cross rope. Nos. 1 of squads 5 and 6 connect the rear toggles to the coupling rings by means of a knot in the rope loops. After this the same numbers toggle the ascension rope at the command of "couple."

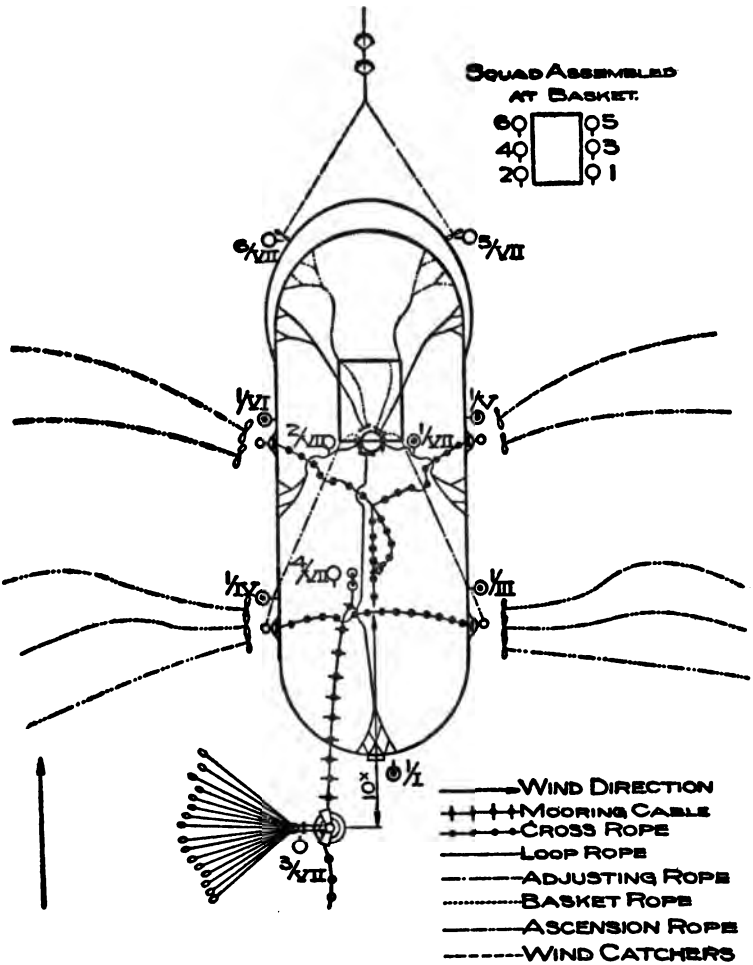


FIG. 18.—Coupling for Ascension by the Balloon Squad.

Nos. 1 and 2 take the forward adjusting ropes and pull them under the cross rope to the car. They then tie them to the loops on the car.

Nos. 5 and 6 fix the rear adjusting ropes to the car; this is done by means of the ring.

For the coupling of the car to the loop ropes No. 1 puts the ring on the forward edge of the car and fixes the large toggles. No. 2 gets the forward adjusting ropes and pulls them over the cross rope to the ring and gives it to No. 1 for coupling. No. 1 toggles the forward adjusting ropes and the middle toggle. No. 2 helps with the other lines.

No. 5, left middle adjusting ropes.

No. 5, left rear adjusting ropes.

No. 5, left flank adjusting ropes.

No. 6, right middle adjusting ropes.

No. 6, right rear adjusting ropes.

No. 6, right flank adjusting ropes.

No. 1 of squad 2 carefully opens the packed-in ripping-panel rope and gives it to No. 1 of Squad No. 7, who pulls it through a ring to the car.

Nos. 5 and 6 of squad 7 handle the tail cups, watch the car, and collect the car message-carriers.

For the ascension with a movable pulley No. 3 lays the mooring cable in the movable pulley. He puts the pulley about ten paces from the rope lock and then stations himself at that point.

No. 4 couples the rope lock.

Nos. 3 and 4 lay the pulley line in the rope pulley.

When ascending with the stationary pulley No. 3 puts the mooring cable in the pulley and the rope squad has the rope ready and hooks it on.

After Nos. 1 and 2 have coupled the car station connections, they have to see that the telephone connections are well insulated at the rope lock.

At the command "To the ascension ropes," Nos. 1, 2, 3, 4, 5, and 6 are arranged in groups at the ascension ropes. Squads 1–III and 1–IV seize the forward and squads 5–VII and 6–VII the rear ascension ropes.

CHAPTER IV

Training of the Field Balloon Company

Field Transportation and Parking. The park of a field balloon company consists of:

Six gas wagons.
One balloon wagon.
One rope wagon.
One requisition wagon.
One ladder wagon.
Two provision wagons.

The gas wagon and rope wagons are driven, in time of war, by six horses; in time of peace, by four; the requisition wagon is always driven by a team of saddle horses.

The line of march is formed, two abreast, in the following wagon procession:

The gas wagons 1 and 2, the first team.
The gas wagons 3 and 4, the second team.
The gas wagons 5 and 6, the third team.
The balloon and rope wagons, the fourth team.

Each team is under the command of a subaltern officer; thay are ranked according to the judgment of the commander of the balloon company.

A reserve squad of men and horses is provided with each company.

The normal position of a field balloon company is in a

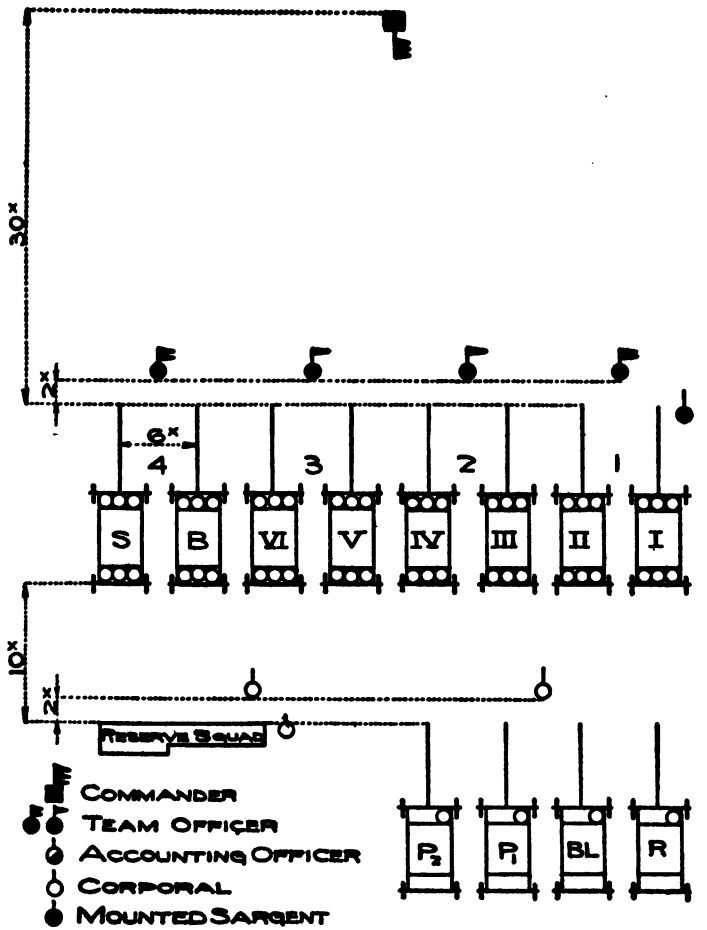


FIG. 19.—Posted Company.

closed line, with the men and drivers mounted, as shown in Fig. 19. The four teams of the company stand in numerical order (that is, the number they have in general service), from right to left, with six paces between, and in every team the wagons must stand next to each other.

The span between is to be measured from the point of one axle to that of the other.

The commander stands thirty paces distant from the middle of the company and faces it.

The team officers stand two paces from the middle of their teams and face the commander.

The mounted officer rides behind, then in advance of wagon No. 1. The reserve squad and provision wagons are ten paces behind the first line.

The reserve squad consists of one unmounted corporal and fourteen men who serve as grooms for the saddle horses of the wagons, and the unharnessed reserve horses. Besides these, there are one saddle maker, one blacksmith, reserve drivers, and the servants of the officers.

The balloon squads and the unmounted drivers are formed in two files, on the right flank.

Six paces from these the reserve horses stand, facing the right flank. The corporal stands two paces from the right flank facing forward.

The accounting officer stands one pace to the right of the reserve squad.

Duties of Team Officers. The commander of the balloon company stays at that place where he can best pass judgment upon the formation and maneuvers of his division.

The team commanders must lead the way according to

the given commands and stay within a given space, but they can leave their places if necessary.

They give commands when marching by waving their hands, and make them still clearer by turning their horses, or by changing the pace. Exceptionally they give their directions moderately loud by command; during certain conditions of fighting, such as a sudden attack, the commanders must use their own judgment to full extent. This holds true also of the squad officers of the second line.

Commands, Sword Signals, and Signals. The movements of the company are regulated by the commands, sword signals or signals.

The commander must, at the beginning of the training, give both the commands and the sword signals. When the training has advanced to a certain degree only sword signals are used. In case the commander wishes to direct by means of sword signals only, he can give these while riding or upon halting. They must be given at a certain distance from the company and from the right place. They are given slowly and clearly, so that they are easily understood.

The sword signals are as follows:

Holding the sword at arm's length, with the point upward, means "Attention."

For emphasizing, *the handle of the lifted sword is turned often in the hand, a little to the left or right.* This signal is to be given before every command, as well as before every sword signal.

If the lifted sword is suddenly lowered, with the point to the ground, that means "March, step-march, or halt."

Every command is to be accompanied by the sword signal.

The direction of march is given by means of *the sword, with arm outstretched in the direction to be taken, and with the sword's edge turned downward.*

For changing to a trot *the arm with the sword is extended upward.*

For changing from a quick march to that of the usual pace, *the arm is held in the same way as for the trot signal, only that the point of the sword is downward.*

To change from a trot to a gallop the arm is held in the same way as for the trot signal, *but the sword is pointed in the direction to be taken.*

To slacken the pace the sword is brought forward with outstretched arm in the horizontal position with the blade down and swung slowly backward in a quarter circle.

This signal toward the left (right) means the slackening of the pace of the left (right) flank; when given to both sides, that the entire company should slacken its pace.

In order to increase the pace of one or the other flanks accordingly, *the sword is held out with outstretched arm in the direction of that wing, and is slowly swung backward in a quarter circle. If this signal is given to both sides* it means that the pace of the entire company should be increased.

For swinging toward the right, *the commander swings his sword in a semicircle over his horse's head, and swings in curves in the air several times.*

For swinging toward the left, *his sword is swung in curves in the air several times.*

Should the balloon company turn to the left, then *the*

sword is held with outstretched arm over the head, and swung in curves in the air several times.

Should the turn be toward the right then his direction must be first *indicated by the outstretched arm and sword.*

For advancing to the inflating position, the commander indicates the direction, *lifts the sword to a vertical position and swings the sword slowly at arm's length, downward several times to the left and right.*

For marching up a balloon company from the rear on both sides of the balloon the commander must point his sword to the left or the right in front of the center of the front to be taken.

For drawing up on the flank the commander goes to that side and gives the direct signal for drawing up.

After each command and each sword signal the signal for execution is to be given, whereupon the execution of the signal immediately follows.

For forming a column from the closed lines toward the front the commander indicates with his sword the line along which the column is to be formed and at the same time commands the direction.

If the column is to be formed on the flank then this is to be commanded and the direction signals are to be given on the flank.

For forming the march column the commander indicates with his sword the wagon from which it is to be formed and at the same time gives the command.

If the sword is swung at arm's length once to the left and right of the body, it signifies "Dismount or Mount," according to whether the men are mounted or dismounted.

Application of Different Paces. A successful operation of the balloon company can be obtained only when it is able to arrive at the desired place on time. The result is therefore partly based on the training and endurance of the horses.

If the balloon company goes along with regiment bearing arms, then the regiment regulates the pace of the balloon company. If it marches alone, then the pace is regulated by the distance to be covered and by the existing conditions in the country to be traveled.

The marching pace is the one usually used for marches.

The gunners follow their wagons two abreast. Upon the command of their officers they march to the right or left or both sides of the wagons, all according to the order of their numbers.

When preparing for an attack alone, and if the condition of the ground permits, it moves into a trot.

When advancing to the place of battle, long distances can be covered by intermittent trotting and marching at the rate of about four miles per hour.

During the trotting the gunners must be seated on the wagons. The trotting pace is to be maintained as long as conditions permit. The gallop is only to be gotten into from the trotting pace.

The steadiness of the pace is of great importance. Therefore a pace-regulating officer must be always on hand.

Mounting and Dismounting. The mounting and dismounting of the details is ordered by the commands of "Mount and Dismount." All mounted men mount or dismount accordingly. All those who have room for dismounting slip two paces sidewise and after the command

of " Mount," take their places again. Should the gunners only take their places, then the command of " Gunners mount or dismount " is given. The Nos. 1, 2 and 3 sit in the front. No. 1 mounts from the right; 2 and 3 from the left; 4, 5, and 6 sit facing the back; 5 and 6 mount from the left side and 4 from the right side.

Every man holds his gun in the outer hand, holds on to the handle of the wagon with the hand toward the wagon, places the forward foot on the running step and then on the footboard of the wagon, and then sits down. The gun is placed between the feet with the muzzle upward and is held with both hands. When the march commences, those sitting on the outer side seize the lines and the middle man links his arms through the one next to him, etc., and they then place their feet firmly against the footboard.

Upon the command of " Gunners Dismount " the men get down on the same side that they were sitting, those on the outside getting down first.

Maneuvering. The dressing of a front line of a balloon company must always be done toward the front. For that reason the men of a company must halt at least a wagon's distance behind the front line which is to be overtaken. The command of " Right or Left Dress " is then given. The company dresses according to the guides.

Upon the sword signal of march the wagon columns precede the commanders and take the distance at intervals according to their column leaders. Line No. 2 closes up to line No. 1 and takes the distance and direction. The indicated direction of march is given by the commander of the company by means of any perceivable object, or

by outstretched arm and riding in the desired direction. The other column commanders must follow at the same pace as that of the direction commander, and at the same interval.

The mounted wagon drivers of every column must overtake the distance and interval of their commanders. They must follow the pace and direction of the column commanders. The middle and perch men must see that the pace of their horses is increased or slackened and that outriders follow the column commanders at the right pace.

During a front march less attention is paid to the exact direction than to the straightness of the march. The front march must be done by marching and trotting. This is to be practiced as much as possible.

Land obstacles which cannot be gotten over by the single teams or wagons must be driven around under the command of the commander without interrupting the procession of the neighboring ones, and must come back into their places as quickly as possible.

For carrying out the front march the command of "Forward March," either step or trot, is given.

The commander of the front wagon column takes charge of the direction of the march. If the commander must, which is very rare, give the commands for the direction of another column, then the command of "Direction—Column Step, Trot, March," is given.

The commander supervises the keeping up of the direction of the march through the commanders of the columns, as well as the proper driving of the column and wagons. This is done best from a position in the rear.

The holding in of the front and an even swift marching pace are best supervised from the side. In order to change the line of march from a straight one to that of a 45° angle the command of right or left "oblique" is given. The commanders of the columns at the same time make a half turn and march in the direction of the column, so that

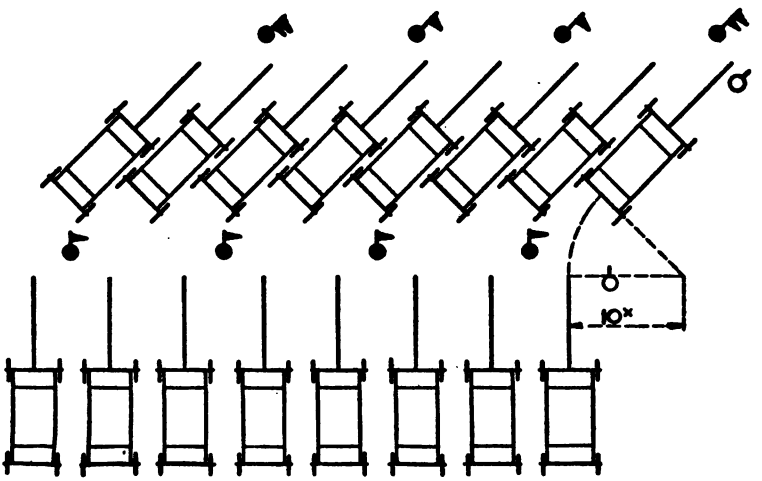


FIG. 20.—Right-Oblique Movement.

the column, wagons and commanders remain parallel to the former front line. (Fig. 20.)

Upon the command of "Forward March" the former attitude is to be taken in the new direction.

Wheeling. The changing of direction of march by means of wheeling is done at the most convenient angle, which must not be over 90°.

For wheeling in closed lines, the commander gives the

balloon company during the march the command, " Right, left (half right) wheel, step, trot, march."

During the right wheeling the right, and during the left wheeling the left wing, is called the pivoting wing; the other is called the fluctuating wing.

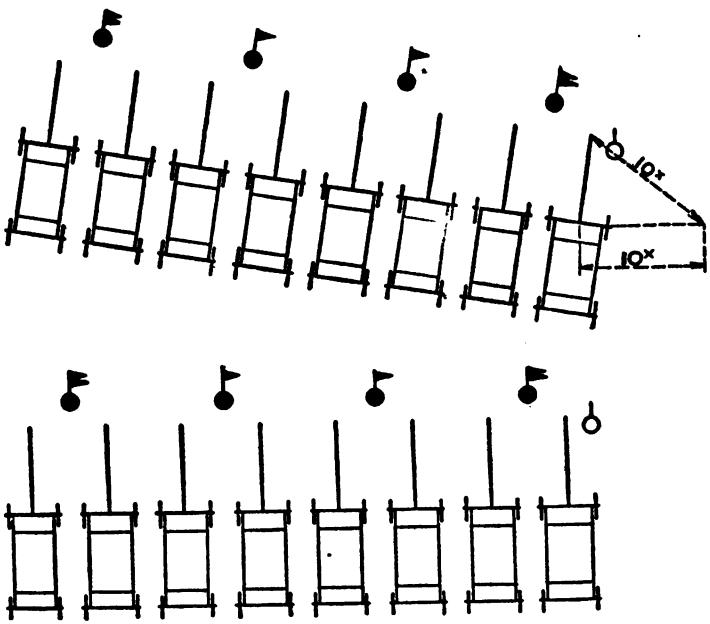


FIG. 21.—Wheeling Movement.

The pivot turns upon a circle whose diameter to the inner advance horse measures 20 paces. The ground which is covered by this circle is determined by the new direction of the march in view. (Fig. 21.)

The other teams turn, led by their commanders, keeping the before-mentioned interval from the pivot.

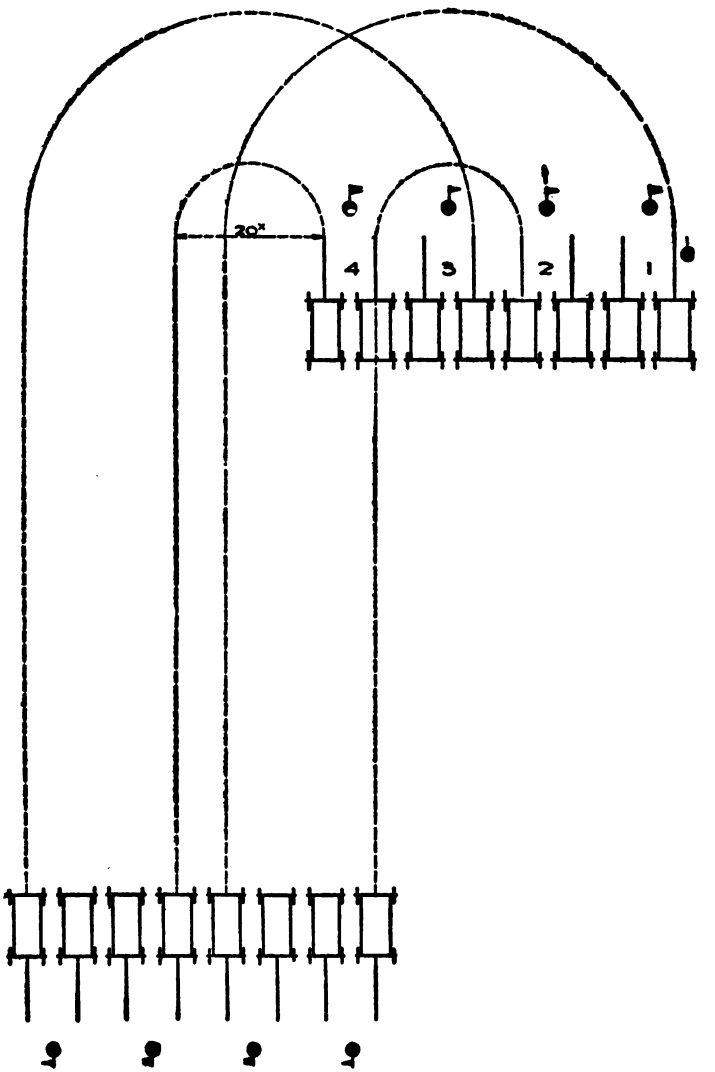


FIG. 22.—Turning Around.

The wagon procession of the fluctuating wing must proceed a certain space at the beginning of the pivoting, so as to prevent a shortening of the interval.

The commanders of the team stand facing the front during most of the pivoting.

The pivot must during this movement keep in step to increase or slacken the pace.

In a column the back part of the column swings around to the pivoting point of the front.

When the wheeling wing is at horse's distance from the new front line, the commander gives the command, "Direction." Whereupon the march is resumed at the original pace in a straight direction.

Turning Around. The turning or formation of the front in a closed line is done upon the command of "Turn, right, step, trot, march. For ending the turning or formation it must be done in time by the seasonable command of "Forward." (Fig. 22.)

Inflation Place. The formation of the company for inflating and placing of the balloon is called the place for inflation. (Fig. 23).

The company forms itself into two divisions:

The first three teams and the gas wagons 1 to 6 stand in front in order of numbers: the fourth with 1 balloon and rope wagon in a closed line about 50 paces in the rear of the gas wagons.

1. The first team stands in front in a closed line with one step interval in the direction given out by the commanders.

2. The second team rides to the right.

3. The third team to the left of the first.

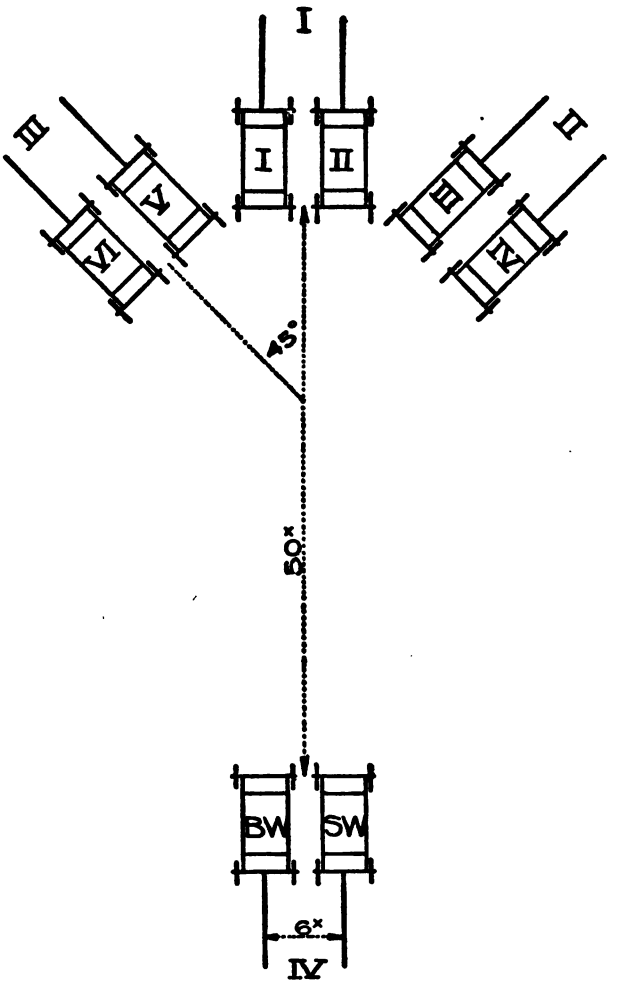


FIG. 23.—Inflating Position.

The distance between the teams and between wagons must measure one pace from axle to axle.

The commanders of the teams stand two paces in front of the middle of their teams.

The drawing up of the four teams is to be adjusted to the ground condition.

For drawing up upon a small space no definite formation is given—and the best formation is left to the judgment of the commander.

During the inflation the commanders of the first three teams must dismount and give their horses to the outrider of their team. The driving up to the inflation position is done from the march-column to a column. In necessary cases it can be formed upon a place out of the closed lines, in which case the fourth team drives back to the line and the other teams proceed to their places.

The commander directs from his position the direction and the middle of the drawing up of the first division.

The drawing up takes place upon the command of " Step, trot,—march, forward " of the company commander with the simultaneous sword signal.

Following this command the first wagon of the marching column must halt upon the signal of the commander of the balloon company; the second is ordered to advance to the right forward with one pace interval. The rest of the wagons drive singly into their positions.

The changing from the column position into the inflating is done in teams.

The four teams march in a closed line, advance 30 paces in the same direction as before, and are then ordered by the

commanders of the teams to turn around and proceed to their places.

Direction for the Column. The column can be formed upon one of the flanks to the front or side, upon standing or during the march. The columns form a closed line when standing in sections, according to the space and in the commanded place, one after another. During the movement the leading column keeps its own pace or takes the pace as ordered. The rest of the sections await the last, remaining standing, and line up slowly in back of the lead according to their order.

In case the formation is done during the marching in trot, sideways, then the head column to prevent the others from getting behind, must advance forward a wagon's length before the swinging is begun.

The formation of the columns from the inflating position is analogous to that of the closed line.

During the movements of the columns the leader of the first section of the column gives the direction. During the march, the distances (intervals) can be changed by the command, " Distance, interval in steps, step, trot, march." The intervals are to be adjusted in comparison with the team commanders.

When the road is narrow the mounted charges march in front of the wagons. The development of the column is usually done in trot. During the movement the leader marches in time or slackens his pace. The single sections of the columns, after they have formed, take the pace of the lead and after the advance has been completed they take the former pace, at the same time as the commanders of the " Direction Teams."

The commanders of the teams must see to the direction and be assured that the front line is correct, leading their teams the shortest way to the front.

The March Columns. (Fig. 24.) The wagons in the march columns follow singly at a distance of three paces; the distance is to be measured from the back of one wagon to the head of the advance horse of the following wagon.

The wagons in the march column are numbered from front to back; disregarding their service numbers, using whichever number happens to fall to them according to their momentary position.

For formation of the march column in flank to the front or side there are given the commands of

March Columns { right, left, forward.
right, left.

Step, trot, march, direction.

Out of a closed line or out of an inflating position the wagon in question takes the direction; the other wagons start the movement when there is room to file into the marching column.

The change from the column to the march column is made in a similar way; every following team files itself at the necessary distance behind the lead team.

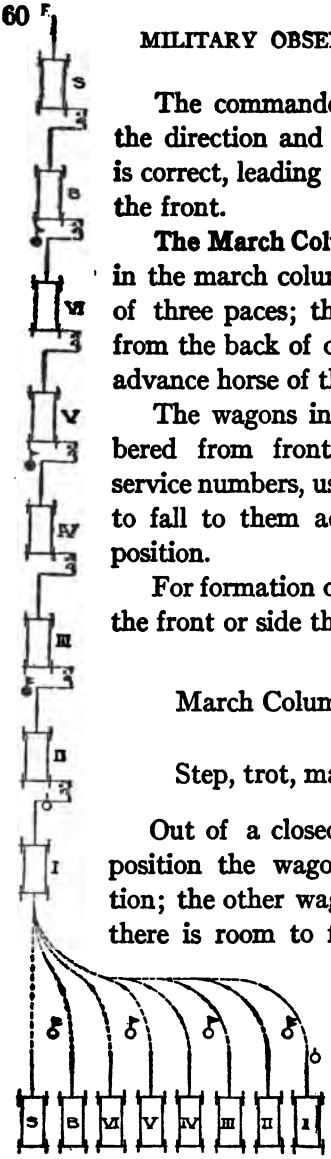


FIG. 24.—March Column.

Closed Lines { forward. / right, left forward.

Trot, march, direction.

The team commanders go quickly in front of their wagon teams, cause these to draw up, and lead them to the front.

The head wagon proceeds straight forward at the same pace as the team commanders. The second wagon advances to the front in a trot to the drawing-up side, slowly, to the before-mentioned interval, and takes the same pace as the team commander.

The following wagons must take the corresponding turning for crossing to the drawing-up side.

During the development, 1 and 2 team march to the right forward and 3 and 4 left forward, and the teams move to their corresponding drawing-up side to the front.

The development on a flank is done upon the command of

Closed Line { Left, right. / Half left and half right.

Step, trot, march, direction.

In a closed line at the order of commander of head team the first wagon turns in the given direction and goes quickly to the new position. The second wagon proceeds straight ahead until it arrives by taking the corresponding turn, at the prescribed interval, in the new front line, when it takes, like the first wagon, the pace of the team commanders.

The other wagons march up in teams to the side com-

mand and are led by the corresponding turning to the new front. From crossing into the inflating position on a flank, the lead is commanded to swing in the required direction and then the commands for marching up and for placing for inflation are given.

Columns. In the columns the single teams follow ten paces apart. This distance is measured from the back of the front wagon to the head of the advance horse of the following wagon. In every team the two wagons drive next to each other at an interval of six paces.

The team commanders ride two paces in front of the middle of their respective teams.

The first (front) team commander has the command; the other mounted charges, eventually divided, remain in their places. For forming of the column upon a flank forward or to a side, the command is given

Column { right, left, forward.
right, left.

Step, trot, march, direction.

The remaining columns swing according to their number to the given side and follow the lead. The wagons denote the necessary interval.

For passing from the march columns to the squad columns the column commanders go to their columns and proceed in the given direction. During development the first column marches during the pivoting. The other column completes the advance and pivots only at the pivoting point of the head column.

For developing forward toward both sides or to one side the command is given:

Closed Line { forward.
right, left, forward.

Step, trot, march, direction.

The command of the column division of the lead goes straight ahead or takes the new direction. These two wagons set the interval during the procedure.

The rest of the wagons are led to the side until they have reached the corresponding interval, whence they proceed straight ahead.

The leading team swings immediately in the closed line, while the remaining teams march off, in order that enough time may be allowed for turning in the new direction and the lead to the front. When drawing up before a sloping (or oblique) place, the teams settle the distance to the left during the drawing up toward the right wing team.

For development into full position in a wing, the leading team is ordered to turn in the direction in question, and then the command is given to draw up in the full position.

Ceremonies. The balloon division is formed in a closed line for reviews. In case a balloon division stands with other troops, if there is room enough, it takes a position at a distance of fifty paces from the latter.

In a closed line, the commander stands thirty paces in the column, ten paces in front of and fronting the division.

When the reviewer arrives, the commander of the troops orders the bugler to sound "Attention," and as soon as they are thirty paces from the reviewer, commands "right dress"; whereupon the commander reports the number of wagons.

If the rank of the reviewer demands the sounding of the general march, then the bugler must at the command of " dress " start the same and may only stop when the commander commands " Halt," or orders this by a sword signal.

The division commander salutes after he has commanded the turning of heads and takes his place after the reviewer is thirty paces past the division.

In case the reviewer wants to inspect the back lines of the balloon division the commander must give the command at the same time of the head-turning.

" Second line, left (right), dress."

Marching Past. In marching past, the balloon division forms a closed line or into columns.

The commander of the division is two paces in front of the middle of the line of the team commander.

The division commander gives the command of " March past, right, left," according to the formation.

The commander commands the turning of the head at about thirty paces from the passing point whence the bugle starts to blow the general march and continues until " Care " is commanded, which must take place when the balloon division has gone thirty paces past the reviewing point.

The team commander does not execute the turning of the head at the reviewing point.

Charges and privates take the described position, and in passing face the reviewer.

CHAPTER V

Inflating and Handling of a Kite Balloon During Maneuvers. Duties of the Balloon Squad. Duties of the Car Squad; of the Rope Squad. Balloon Transport, with Ascension Ropes; Transportation Ropes. Aid of Crew. High Transportation. Marching Order of the Balloon Transportation. Lifting over Obstacles. Deflation and Refilling of the Balloon.

Inflating and Attendance of a Kite Balloon

The attendance of a balloon is the same as that described in Chapters VI, VII, VIII.

Inflation. For inflation the men march up and dismount. The dismounting must take place at a level place which is sheltered from the wind and hidden from the enemy.

Balloon Squads. Upon the command "Lay out balloon" Nos. 1, 2 and 3 must do the following:

No. 1 opens the locks and throws back the box cover.

No. 2 lets down the tail piece.

No. 3 takes the back footboard and puts it on the right back wheel; 1, 2 and 3 take the back seat off and put it the same way on the left back wheel.

No. 2 takes the hand mallet, the screws and valve keys and places them on the cover of the valves.

Then Nos. 1, 2, and 3 make hose connections with the joining pipe by means of a wrench. In case the connect-

ing hose does not reach from the wagon to the joining pipe, then the hose Nos. 2 and 3, if necessary must connect the wagon to the joining pipe and the reserve hose.

In connecting the hose the hand mallet must first be siezed by No. 1, the coupling being done by light blows, and then given to No. 2 and to No. 3.

Then No. 1 stands to the right of the gas wagon, while No. 3, after having placed the hand mallet upon the cover of the requisition box, stands to the left of the connecting hose and back of the wagon, facing the hose.

Then No. 2's step to their groups, No. 1 and 2 of Squad 6, after they have finished with the work of their wagons, go to the joining pipes and take with Nos. 4, 5, and 6 of the car squad, the laid-down reserve hose, the inflation hose, inflating pipe, reserve filling hose, and the soft ropes.

Upon the command of "Lay out Balloon," Nos. 4, 5, and 6 of the various balloon squads go to the balloon wagon, taking their places according to Fig. 25, in three sections facing each other, so that like numbers are placed in order. Under the supervision of the balloon officers, and with the aid of squad No. 7, they unload the balloon, together with the blanket, in such a way that Nos. 4 of the 1 and 2 squads seize the balloon near the valve and pull it toward the given direction from the wagon. The remaining numbers of the 1 and 2 squads place themselves at three-pace intervals under the balloon; the rest of the squads then follow.

The men must stand under the balloon in pairs and place their inner hands upon the shoulders of their companions. In this way they make the carrying of the balloon easier. The balloon, which has been lifted from the wagon,

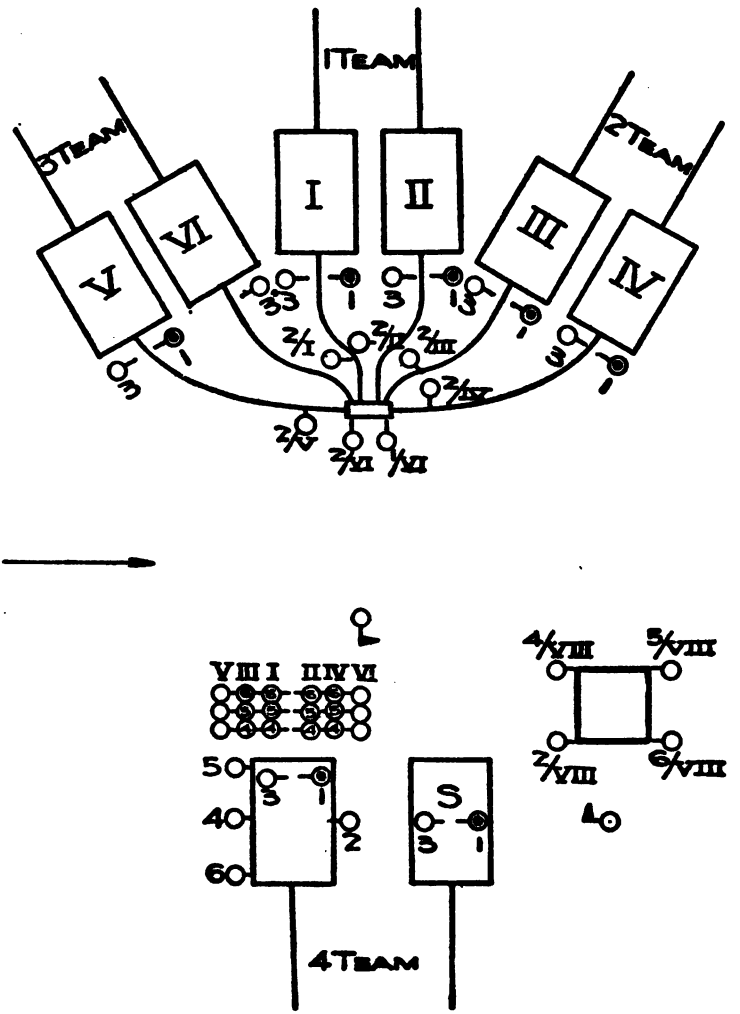


FIG. 25.—Inflation I

is brought in such a way to the free end of the inflating hose that the filling pipe, after the balloon has been laid out and the hose stretched, can be shoved into the appendix. The balloon officer commands "Halt," as the balloon stands with its valve toward the wind. Then "Put up," when the envelope is stretched open. Then "Lower the Balloon." The folded envelope is let down, the squads kneel upon both knees and are ready to unfold the balloon.

The unfolding takes place upon the command of "Lay out right (left)," in such a manner that the upper layer of goods together with the blanket is unfolded by the men who are kneeling at the right and left.

After unfolding, the loops must be pulled in and laid ready.

Nos. 1 and 3 of the sixth wagon buckle the inflating hose to the connecting pipe in the meanwhile. The other end of the inflating hose, together with the filling pipe, is shoved as far as possible into the appendix of the balloon, and is tied with a soft cord. The filling hose must not become kinked and should be stretched only a little. The reserve inflating hose is placed next to the inflating hose. The men stay under the balloon during the inflation. (Fig. 26.)

During the inflation No. 1 of Squad 1 serves as inspector and stays upon the side farthest from the wagons.

The gas tank of the first wagon is opened by No. 2 of Squad No. 1.

When all preparations have been made the balloon officer gives the command of "Inflate."

Nos. 1 of the first five gas wagons open the valves of the right gas tanks of the upper rows. The next valve is

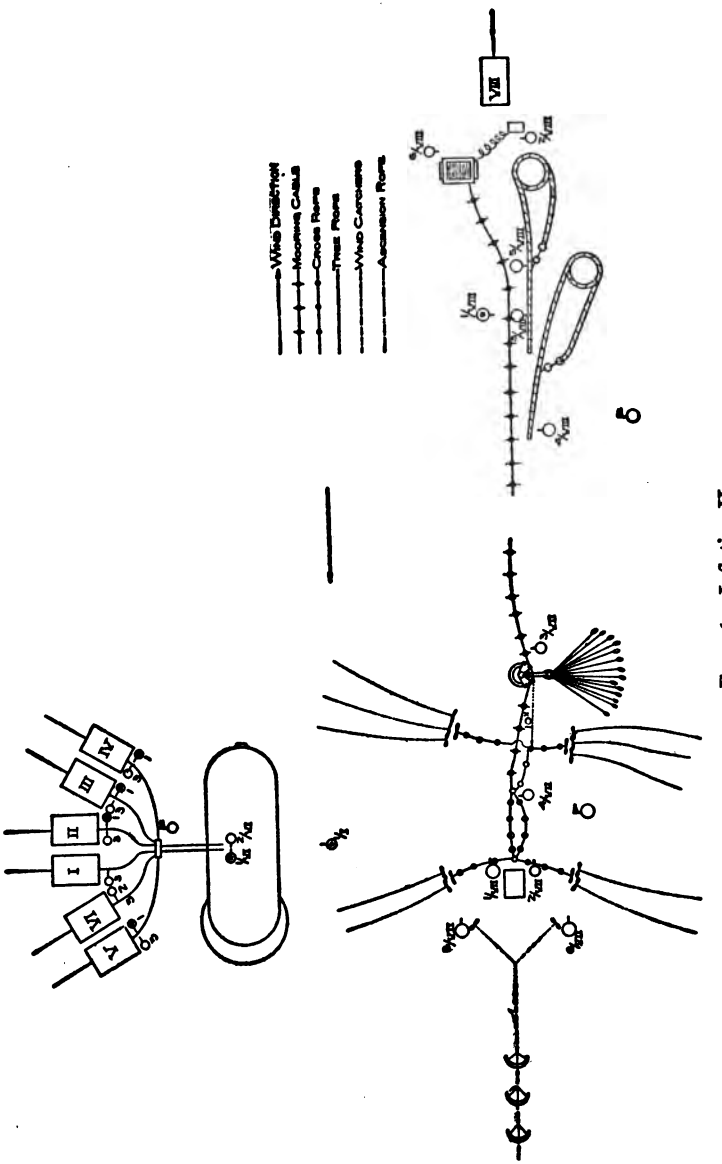


FIG. 26.—Inflation II.

to be opened only when the preceding one has been partly emptied. In case a valve blows very strongly it is to be closed without necessary commands. The tanks can never be entirely emptied on account of the diminishing pressure from within.

The balloon officer regulates the inflation by a signal whistle and by waving his hand.

By a shrill whistle he calls the attention of the men at the valves.

The lifting of the right hand commands the hastening of the inflation.

The lowering of this hand is an order to inflate more slowly. When he whistles twice and at the same time swings his hand over his head the inflating must be stopped.

Every man is ordered to report a serious gas leak as soon as he notices it.

The inflation is to be suspended when there are still 50 cubic meters lacking for the entire volume. This is because the gas coming from the tanks has a considerably lower temperature than the surrounding air.

In case five gas wagons are not enough for inflating, then No. 6 must be pulled up in line. During the inflation the balloon squad must gradually let the balloon up on the rigging, according to the increasing inflation. For ending the inflation the same signal is given as that for continuing inflation.

Duties of the Car Squad. Upon the command of "Seize the Requisitions" the locks are opened by No. 1; No. 2 lowers the hull lock. Nos. 4, 5, and 6 fasten the reserve inflating hose to the joining pipe and place it upon the right

side of the wagon. Then Nos. 2 and 3 pull the peg out of the back footboard so that it falls down.

Nos. 1 and 2 open the cover of the wagon, No. 3 takes off the back seat and uses it as a prop for the cover.

No. 4 takes the filling pipe, the inflating hose, reserve inflating hose, and soft cord from the wagon and places them, together with the joining pipe and the reserve hose, at the same place where Nos. 5 and 6 had placed the connecting pipes.

As soon as the envelope of the balloon has been taken out of the wagon the backboard is placed in again, and the cover of the wagon is locked by Nos. 1 and 2. The back seat is put up by No. 3

The car squad marches to the rope wagon and carries the car and its equipment to the balloon, placing it where indicated by the commander of the division. It is set with its long side to the wind, when preparations for coupling are started.

The Rope Squad. Upon the command of "Seize the requisitions" the locks are opened by No. 1. No. 2 lets down the sprag and with No. 3 pulls the bolt out of the back footboard so that it hangs down. Then Nos. 1, 2, and 3 open the lid, propping it with the back seat, take off the backboard and place it upon the front footboard. Then these numbers unload the car and its equipment. Nos. 4, 5, and 6 put it upon the ground next to the wagon from where the car squad take it.

The commander of the second ground station leads the rope wagon to the spot appointed for the anchoring of the mooring rope, which is then laid out.

The coupling for ascension is done as previously de-

scribed, or by two men from the balloon squad who must be replaced during this time.

Balloon Transportation

Ways. The transportation of an inflated balloon can be done in the following ways:

High transportation with or without car.
On the ascension ropes.
On the transportation ropes.
High transportation by means of the mooring rope.

Carrying Out the Transportation. Upon the command of "Balloon, transport, direction, march," the movement for transport is begun.

The halting of the movement follows the command of "Halt."

The speed for transporting is decided by the strength of the wind, the condition of the terrain, and the strength of the crew.

In order to have reserve and anchoring material at hand, under difficult conditions, every transported balloon must be followed by a hand wagon loaded for these requirements.

This wagon must be sent out for the preparing of the anchoring, only when it is seen that the balloon is reaching its destination.

Should the weather or the terrain conditions make it impossible for the full crew to complete the transport the balloon should be temporarily anchored.

The cutting open of the balloon is allowed only at a time of great danger and only when the order is given by the Balloon Officer.

Low Transport. In making a low transport the ground must be free from obstacles, especially during a high wind. Low transporting in a high wind is done only for short distances. This method of transporting is used when it is desired to conceal the movements from the enemy.

The balloon is weighed down by sand bags, and when transporting a kite balloon the crew seize the rigging when moving a spherical balloon, the crow-foot netting.

The kite balloon is transported with its head in the direction of the wind. No. 1–1 holds the head in the wind. No. 1–2 carries the valve and ripping line. Nos. 5 and 6–5 and 5 and 6–6 prevent the torus from dragging.

When transporting the spherical balloon, No. 1–1 takes the direction and No. 1–2 carries the ripping line, the valve line and exchange cord.

The numbers 1–3, 1–4, and 1–5 carry the ring and the ascension (lifting) ropes.

No. 1–2 has to see that the ropes are not pulled. This detail must hold the ropes under all conditions, and in the moment of danger, has to be ready, upon command, to rip open the balloon.

Transportation with Ascension Ropes

The transport with the ascension ropes is done only for short distances and when the car has been coupled on. The balloon is let up with ascension ropes to the required height, and then the transportation follows.

Transport with the Transportation Ropes, with Aid of Crew

The transporting of a balloon with the transportation ropes is the usual way of moving an inflated balloon for a long distance.

The transport of a kite balloon is done with or without the car. When the balloon is conveyed without the car it must be weighted down with sand bags, to assure maintaining its kite position.

The spherical balloon is usually transported with the car coupled and fastened onto it and its crew in place.

Three transport ropes, 50 meters long, for kite balloons are fastened in the ring at the hoop of the pulley; in a spherical balloon to the coils of the ring by means of a secure knot. The ascension ropes are left on the balloon.

The preparation for transporting with the ropes is done by the car squad. (See Fig. 27.)

The transportation ropes are laid out in acute angles in the direction of the wind, placed at the necessary distance from the desired transport height, and with two traction ropes.

The balloon is then let up until the transportation rope is taut when the crew are ordered according to their numbers. Upon the command of "Up with the transport line," the balloon is raised and lastly the crew is arranged at the traction ropes, according to their number.

With the Aid of a Vehicle. For relieving the men the transportation ropes may be fastened to a heavily harnessed wagon. If the wind is blowing from the side, the

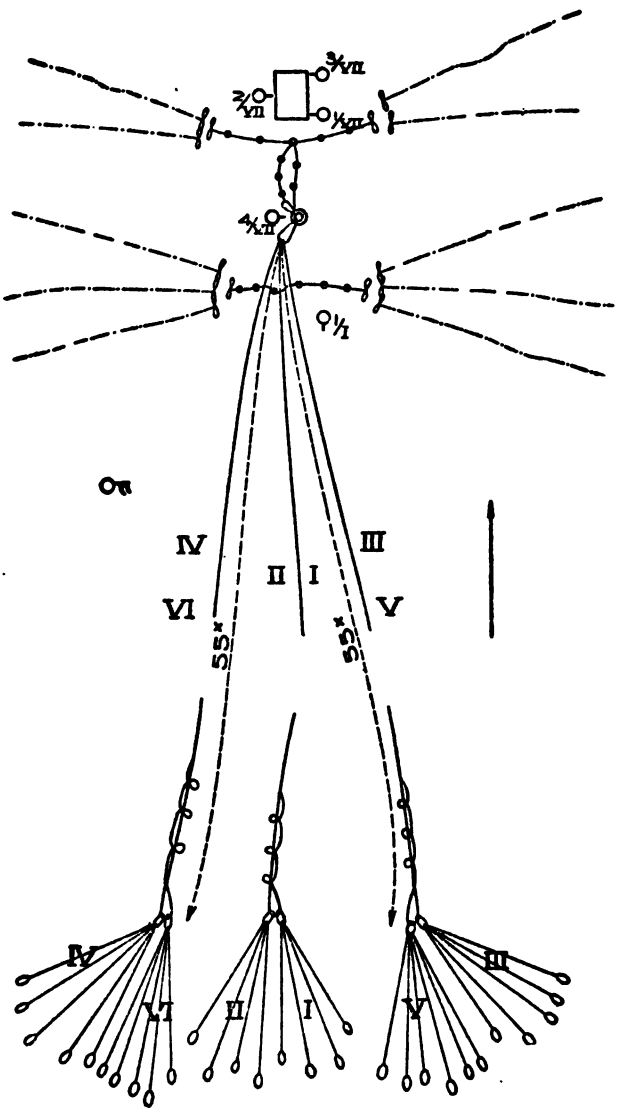


FIG. 27.—Preparation for Transport.

force of the wind must be lessened by holding the ropes toward that side.

High Transportation with Mooring Rope

High transportation with the mooring rope is done when the observation of the ascended balloon is not to be interrupted, when the balloon is shot at, or when the transportation leads through woods, in which case it would be difficult to advance with the use of transportation ropes.

For accomplishing high transportation with the mooring rope, the eyelets of the clamps, which hold the mooring rope by means of S hooks, are to be equipped with traction ropes which are held by several of the crew.

After the movable pulley in front of the clamp has been held by a sufficient force the tree rope is loosened, after which, with the aid of the extra help, the balloon is held fast to the traction rope of the clamp and pulley.

The rope drum, the tree rope, and the telephone connections are brought by the rope squad on the hand wagon.

In case a harnessed heavy wagon is at hand, the clamp can be fastened to the back axle by means of a tree rope, which will make transportation easier.

Marching Order of the Balloon Transportation

A mounted officer precedes the balloon and indicates the way by signaling or by calling out. The advance patrol, composed of the reserve or car party, proceeds at 100 paces, with climbing irons, mallets, ladders, and plummets. The advance patrol must remove any obstacle which has been pointed out by the officer.

The commander in charge goes with the balloon. Ten paces back of the balloon is a petty officer who has to keep the marching discipline and to watch the back part of the balloon.

Lifting the Balloon over an Obstacle

The lifting over telephone wires and similar obstacles during transportation with the transportation ropes is done as follows: The balloon is brought as near the obstruction as possible and after removing the traction rope from the transportation ropes, the latter are lifted over singly, either with the aid of the plummet, the two-pieced fork, or the three-pieced ladder. Two transportation lines are to be held taut at each side. In a spherical balloon the car squad takes the free transportation line into the car and throws it over the obstacle.

The arrangement of the crew of the balloon squads at the ropes is to be regulated by the officer in charge.

In case of necessity during the throwing of the free rope over the obstacle, the crew of the other transportation lines can be called upon.

After the rope has been thrown over and after the traction ropes have been fixed, the crew are ordered to their previous positions.

The last rope which is still free is brought over the obstacle as were the others, or it can be thrown over the obstacle by the crew, who march in and then pull it over. This is done when the telephone wires are crossed.

Sometimes, when balloons are brought across by high transport, telegraph or telephone wires are pulled down, and afterward repaired by four men, two of whom have

climbing irons. Sometimes it is advisable to change the course of the telephone wires. When the wires carry electric power, the commander must see that the necessary precautions, such as disconnection of the circuit, etc., are taken.

When a number of such places are to be crossed it is best to have a wagon at hand which is equipped with the material necessary for repairing of wires.

In case the telegraph wires must be crossed, in high transportation, the wires can either be cut or their course changed, in which case they are to be put back again as soon as possible.

Deflation and Refilling of the Balloon

The deflation of the balloon is for the purpose of letting out the gas which has become useless by losing its power of lifting.

For deflating a kite balloon the two deflating openings on the sides are opened. The balloon is pulled up in front and let down in the back by the men stationed around it. The valve must never be opened. This valve is to be covered with a cap before deflation. It can be covered with a car blanket and rolled up from the front toward the back.

For deflating a spherical balloon the ripping panel is to be opened.

In case the carrying gas of one balloon is to be emptied into another, the one which is to be filled should be prepared as for an ordinary inflation. The appendices of both are to be connected by the filling and refilling hose and made gas tight by tying up with a soft rope. Four men must do this filling.

A kite balloon is deflated by rolling it up, a spherical balloon by pulling evenly on the net meshes.

In transfusing a spherical balloon the ends of the large crow-foot lacings are tied together with a rope in order to lock the net at the lower end.

The sand bags on the balloon being filled are to be spaced equally and the same process is followed as for deflating another balloon.

CHAPTER VI

The Use of a Kite Balloon in Time of War.

Purpose of a Balloon. The balloon is a high-moving observation station, which can change its place whenever required, and can be used on the battlefield as well as in other positions. On account of the limited horizon and on account of the dependence upon the weather conditions, the balloon cannot replace the activity of the other arms; but can surpass them in some important ways.

The main purpose of the balloon is to report the condition of the battlefield and after battle. Balloon reports do not show the results of a battle, but call the attention of the commanders to the existing situation.

The reports have the character of a situation report.

The general results of the artillery fire can be judged from the balloon.

For the purpose of observing the artillery situation and reporting the results of artillery fire, the balloon is an important factor.

The Observation Horizon. The observation horizon is dependent upon the ascension height of the balloon and the weather conditions.

Kite balloons ascend under favorable weather conditions (wind blowing up to 10 meters per second and fresh gas) to a distance of 500 meters and spherical balloons with wind at 5 meters per second to 600 meters.

With strong wind, especially a gale (over 10 meters per second) the kite balloon goes to 300 meters but the spherical balloon cannot be used at all. When the wind is blowing over 15 meters per second the balloons cannot be used.

During clear weather an observation in the circumference of 10 kilometers can be expected. The finding and distinguishing of stationary troops must be done at a much nearer distance. During a heavy fog, rain or snow, observations cannot be made.

Balloon Observations. Balloon observations in general meet with various difficulties. In a closed country they are greatly hindered. In woods and distant places the observer has no clear view. With the sun in the back the observation is easier then when facing the sun. Stationary or hidden troops are much harder to find than those marching or stationed in a clearing; dust or smoke and dark backgrounds hide the observation.

The observer is frequently misled through the fact that such things as plants, swaying hedges, bushes, orchards, etc., are often mistaken in gloomy weather or misty atmosphere for troops or fortification lines. Doubtful cases are decided only after renewed observations from both sides of the car, and comparing with the country. The uncertain reports, charts, or maps, are to have a question mark placed after them.

The observation can be reported in stationary places by giving the fitting balloon signals.

In order to use a balloon to advantage the conditions of the observer's side as well as that of the enemy's must be known. In stationary positions the balloon observer must especially during the preparations make frequent ascen-

sions to obtain an exact idea of the terrain to be observed. The accuracy of boundary reports and reliability of observation of results of artillery fire are essential to success.

A balloon observer must have strength of vision, resistance against the swinging motion, be quick at getting his bearings, be able to understand the situation, calm and conscientious in sending off his reports. He distinguishes the essential from the non-essential. Balloon reports must never contain secondary details. Only that which has been clearly seen is to be reported. Uncertain reports are to be marked as such.

The using of rough sketches and marking on maps is of advantage, as mistakes cannot be made as easily as by telephoning.

Usually two officers can be taken up, the observer and the balloon commander. The latter must have been trained for airship service. To him falls the care of the balloon and the correspondence service. A balloon observer can be appointed if necessary. The balloon commander must aid the observer according to the feasibility of the observation. In case only one person can be taken up, he must be an officer trained in the airship service. He proceeds upon these two named duties, hence the observation from the balloon must naturally be interrupted occasionally.

It is the duty of the observer to change the height and place of the balloon.

In case the officer is wounded or becomes unfit for service he must be relieved. Relieving the observers naturally causes an interruption in the observation, as the new observer requires time to get his bearings.

Service for the Car Station. The conditions seen are

to be reported by sketches or cutting pieces out of maps. These are to be enclosed and thrown off in the carriers or they are telephoned or signaled by the balloon pilot to the ground station.

Services of the Ground Station. The ground station must always, without interruption even during the balloon's transportation, be ready for receiving the reports, which are to be picked up by an officer and repeated, as a record to the car station. The names of the locations are to be looked up on the map. A report by telephone does not have to be changed. The maps must always be handy on the ground station, for marking the reported situation. The ground station must, if necessary, make several copies and dispatch them. Petty officers are to be used only occasionally as clerks, and then with great discretion. No one is allowed to question the observer except the commander to whom the balloon is entrusted and the commanders of the balloon division. Calling the observer should not be permitted, as it interrupts the observation. The dispatching of reports must receive careful attention.

Next Station. In fortification warfare better service for the commanders is made possible by the establishing of additional stations by the superior commander, or by a connection with an existing telephone network. In field warfare the telephone connection is likewise to be tried; if not, the reports are to be dispatched by officers, messengers (mounted), or bicyclists of their own squad.

All the officers in service in the balloon division must study the plan of the battlefield before the balloon is put into service, so that the observation and dispatching can be readily accomplished.

Signals. The visual signals are given mostly for artillery purposes from the balloon car, and are limited only to the control the firing. They are as follows:

Red disk (flag), up. "W."

Red disk (flag), down. "K."

Red disk (flag), turning in a circle, gunner aiming straight.

White disk, turned toward the right, "r."

White disk, turned toward the left, "l."

Both flags turned up, higher.

Both flags turned down, pull in.

Both flags turned horizontally, halt.

In case the air is misty or the balloon is at a great distance, or for lengthy reports, or in case it cannot be done by telephoning, the signals are given from the ground station in the customary way with fort artillery.

Changing of Position. One stays as long in a place as the progress of the battle necessitates. In case this changes its position or in case one wishes to get another viewpoint, the change must be made quickly. If the order of the commander is not received in time, the change of position must be made known to the command. The commander of the balloon division must change upon his own responsibility the position when the battle starts, or in case of a sudden decision for the purpose of discovery or to make the hitting of the balloon more difficult for the marksmen, and must report such change. The shooting of a balloon can very often be made very difficult by simple maneuvers such as ascending and descending. In case a change in position is to be made at such a time, it must be done quickly and when possible in high transportation.

The technical manipulations for leaving and going to another place, colliding with troops, and the interrupted observations, are things which are carefully to be considered.

Balloon Transport. During war it is often necessary to transport the inflated balloon long distances. The manner of transportation is decided by the existing situation—the weather conditions as well as the strength of the men. It is done as shown in Chapter V. During the transport the balloon and rope wagon (with the balloons for forts, the wagons with the necessary equipment) must follow the balloon.

Balloon Escort and Dispatches. Every troop commander to whom a balloon is entrusted must under all conditions see to its safety. The squads, if not the balloon division, must be assigned the necessary escort. In dangerous conditions men whose arms are to be brought to them by wagons may be added for strengthening the escort of the balloon squads.

The commander of the balloon division has to take charge of, and is not relieved under any conditions from, safe transport on his own responsibility, whether the regular escort of the balloon is in attendance or whether men from the next troops have been added. An infantry detachment is usually sufficient for an escort.

The balloon escorts guard the ground station against a sudden attack and must also guard the wagon division within that district.

The commander of the balloon escort studies the location and posts the guards at the most advantageous places for the protection of the balloon from the sudden attacks

and in the best protected places from the enemy's fire. He also dispatches small patrols.

If there is no infantry in front of the balloon, the advance of the enemy is to be stopped by the escorting patrol advancing about 600 feet in front of the balloon.

In case the balloon division retreats after an attack, the escort must protect the balloon until it is safe.

Dispatch riders can be demanded when necessary.

Technical Preparations and Directions. The time required for the technical arrangements depends upon the training of the men and the weather conditions. The usual time is

a. Fortification Balloon Division:

Equipment for the inflating station about	6 hr.
Inflating the balloon	12 hr.
Coupling and ascension	10 min.
Descension	10 min.
Uncoupling and placing the equipments	20 min.
Disconnecting an inflating station	3 hr.
Balloon transport per kilometer	15–20 min.

During a wind over 10 meters per second it can be done only on open ground.

b. Field Balloon Division:

Spreading balloon, about	5 min.
Inflating, about	15 min.
Coupling and ascension, about	10 min.
Descent, about	5 min.
Uncoupling, about	5 min.
Placing the equipments, about	15 min.

Every balloon division must have a day book.

Uses of the Balloon Division in Fortifications

a. General determination.

During battle at a fort, the fortification balloon division can be used. It is an economic administrative subdivision of the fort artillery, stationed at that place and in service under the orders of either the commander of the fort or the commander of the defenders, who use it for artillery observation, as well as for tactical purposes. For the artillery purpose the division is disposed according to the demands of the individual section artillery commanders, eventually to the entire appointed battery division. The oldest ranking commander of the balloon division serves at the same time as relief to the fort commanders.

The following must be considered when using a balloon of the fortification balloon division.

a. Choosing and establishing an inflation station.

b. Choice and reconnaisance of ascension place.

Inflation Station. For the establishment of an inflating station the same rules hold as described in Chapter V. In winter it is feasible to place the gas apparatus in a shed. The commander of the fort balloon division regulates the service of an inflating station.

Inflation stations which are equipped with steel tanks containing mixed gas, such as are often found in forts, do not require long preparations.

Ascension Place. The place of ascension is decided upon from tactical requirements after clearing, the special demands at the time, and also the condition of the country and weather. The place for ascension should be invisible to the enemy, allow free movements, and be on

obstacle-free ground, so that the balloon can if necessary change its place. The place for assembling should be out of range of the shrapnel of the enemy; that is, at least 4000 meters distant from him. In case it is necessary for closer observation, and in case the battle conditions demand it, the ascended balloon can be brought nearer to the enemy. For clearing up a tactical situation, or to determine the results, it is wise to keep the balloon as near as possible to its escorting troops. For observing the results of gunfire, the best position for the balloon is in the rear of the middle of the firing battery. The firing can be done by night and by electrical illumination of the goal. Then the place of ascension can be chosen nearer to the goal and in the opposite direction from the searchlights.

Choice of Inflation Station and Ascension Place. The commands for choosing an inflating station must be given in time to the commanders of the balloon division, so that all material can be brought to the inflating place twenty-four hours before the balloon is to be used.

The commander of the fort must make the following known to the commanders of the sections:

The service of the balloon division, time and place for preparation, and the necessary transportation material.

The superior commander reports the safeness and the incidental conditions of the inflating station.

The commander of the balloon division with another officer locates the position and notes all details for the placing of the inflating station, and the way of reaching it, and sends a sketch of it to the higher commander. The superior commander then arranges the establishment

of the inflation station and decides when, where and for what purpose the balloon is to be used, and from where and how the necessary material is to be transported.

Enough time remains during the inflation of the balloon for the reconnoitering of the ascension place and the transport poles for the inflated balloon. The telephone connections can also be made during this time.

Exploring. The commander of the balloon division, the observer, and the pilot must know the exact situation and the purpose to be attained by the balloon. During an attack on a fort the necessary directions are usually given by telephone.

Attack

In General. The divided balloon division at a fort must during the first part of the attack do observation duty only.

A regular balloon observing service is installed only upon the arrival of the fortification balloon division, which is due with the besieging artillery.

Duties of the Kite Balloon. The first duty of the balloon is to find the best point for the front field where the supplies, etc., may be stacked, and for the newly placed communications of the fortifications. Further reports as to the conditions of the fort and its surroundings as well as its guns are made, and lastly to obtain the tactical measures of the defenders.

The reports gathered during the preparation will make the choosing of the place of attack easier. When the place for attacking is decided upon, a general observation service for the attacking front is started, and the balloons

for artillery range-finding and those for observing the results of the firing are put into service.

Defense

In General. The defender usually has enough balloons to make a general observation from the fort, which can be done at night, with good results.

The balloon can find out the important advance ground positions.

Duties of the Kite Balloon. The balloon must obtain, for the fort commander, the data of the strength and arrangement of the besieging army in the advance field. They must espy the camping place, the field trains and other used communications as well as their activity, and lastly, the arrangement of the attacking ground and the tactical condition of the advance line. All these reports together with those obtained in other ways offer points for finding the probable main direction of the attack.

In addition the balloon must do observation duty for the artillery and also during the battle for the front ground of the fort.

Uses of the Field Balloon Division in Time of War

Field Balloon Division. The field balloon divisions are separate minor divisions, which are directly under the command of the army or the army corps. Field balloon divisions cannot be separated and can only serve the balloon. Those divisions bring the necessary compressed hydrogen in steel cylinders to the place of inflation.

Using the Balloon. The balloon is used in field war, for tactical observation and only rarely for artillery pur-

poses. The time for putting a balloon into service is to be considered carefully since an inflated balloon can follow a marching army only when the weather and land conditions are favorable; one inflation is good for only three or four days, and little inflating material can be kept in reserve. The inflation of a balloon is to be done only on important occasions.

Divisions during Marches. The dividing of the balloon divisions is taken charge of by the general. When marching to battle the balloon division is formed into troop columns, if their employment is probable, and they are used as a vanguard to the leading division.

The Reconnoissance. A thorough establishment by the balloon observer of the situation of the enemy's and his own lines is the main foundation for a successful balloon observation. Otherwise, a mistaking of his own troops for those of the enemy cannot be avoided. During the advance, the balloon observer must know the strength and marching routes of his own columns. During the attack he must be informed of the conditions of his own battle front, the strength of the flanks, and the preparedness of the reserves. He receives this information through the general staff chief or a general staff officer directly and in time; it is not to be given out immediately before ascension, but should be received sooner, so that the observer may have time to study his field. Orders should not be given when the balloon is up, except when absolutely necessary, since the imparting of the instructions interrupts the observation.

Uses of a Balloon during Battle. The general gives the command for ascension. He decides upon the ascension

place and the time when the balloon is to be let up and when the carriers are to be sent. The place of the corps supplies is to be made known to the commanders of the divisions.

In counter attacks it will be of advantage to let the balloon ascend as soon as possible in order to obtain a definite idea of the strength and developments of the enemy.

During a stationary attack the balloon is to be used in that place from where the best view of the strength, position and actitivy of the enemies' reserves can be obtained.

During an attack the best opportunity for balloon maneuvering is given. The balloon can ascend from the shed near the place of attack and a telephone connection between the balloon and the general can be arranged to advantage. To report the advance of the beseiger, the grouping of the men for the attack, and lastly the attack against the flank and the advance of his own troop, compose the main duties of the observer.

Inflation Place. The inflation place must be outside the gun range of the enemy's artillery and should be in a place sheltered from the wind and near the place of ascension.

Ascension Place. The selection of a place for the ascension depends upon the tactical conditions and the bases which were selected for attacks against fortifications. During open warfare, ascension places cannot always be chosen away from the enemy's range.

Commander of the Balloon Division. The commander of the balloon division must always be in communication with the superior commanders, and kept informed as to the aims of the generals and the results of the battle.

During an attacking march he must march in the same staff as the observer or be represented by an officer of the division. The division is led by the oldest team commander.

The commander of the balloon division must, before the ascension, see that the observer understands the exact location, so that the observations will be taken from the right place.

During the march the commander of the division watches for a satisfactory place for the ascension.

Before advancing to the inflating position he hurries forward to decide upon the ascension ground and chooses, if possible, a hidden way for marching, giving the order in time, either by commands or signal. He sees, in case the ground is not safe or in bad weather, that they are accompanied by an escort. In case he deems it feasible, he should ride toward them and lead them to the spot.

The driving up for inflation should be done, whenever possible, under cover. After the division has arrived at the place of inflation, the commander gives the commands necessary for putting the balloon into service. In case the balloon division must be in readiness shortly after arriving at the inflating ground, the team commanders must hurry to the commander of the division, who gives them the necessary directions and then orders the driving in of the division.

CHAPTER VII

The Rules for Examining and Accepting the Cloth to be Used in the Manufacture of a Kite Balloon. The Care of Material and its Repair

Examination and Acceptance of Balloon Cloth

The examination and acceptance of the balloon cloth is divided as follows:

1. Examination of the plain cotton material before the dying and rubberization.

2. Examination of the rubberized material.

The cloth must be examined by commissioned officers of the aeronautical department, in the presence of the manufacturer or his representative, to see if it answers the necessary requirements.

The cloth from the various manufacturers is to be examined in sections and a single piece as a testing piece must be chosen by the examining officer.

It is of advantage to choose as a test piece one which feels as though it were of an inferior quality.

The number of samples to be tested per piece is to be left entirely to the judgment of the examining officers. Here it can be stated that when the material is put out by a reliable firm and in large quantities and when it seems to be of the same consistency in color, weight, and touch, a smaller number of testing pieces is needed than when the cloth looks variable and seems to be of an uneven quality.

The unrubberized cloth must be examined to see if it has the necessary number of warp and weft threads and if it has the required weight. If this is found to be so, it can be taken for granted, fairly accurately, that the cotton has the required strength and that the weave is of the necessary closeness. Then it is to be determined whether the cloth has been prepared or if there are any defects in weaving. The plain cotton material can be washed, but not bleached or mangled.

In obtaining the weight, the test pieces are to be weighed separately and the weight is figured.

On account of the difficulty in obtaining an even consistency of the cloth, a difference of 3 per cent over the given weight is allowed. Lighter material, if it possesses the given minimum strength, can be accepted.

Three pieces are to be cut from the samples which are chosen for examination, 24 cm. long and 8 cm. wide in the weft and warp direction of the threads and then examined. The test pieces are to be taken from the ends of the pieces of cloth as well as from the middle. The technical examination starts with the tearing test of the dynamometer, in which the testing pieces 16 cm. long and 5 cm. wide have been stretched.

Cloth whose ripping resistance is 5 per cent less one way than the other cannot be accepted.

The counting of the fibers in the warp and weft is to be done on a surface 1 cm. square, and to facilitate this a thread counter can be used.

If the difference between the warp and weft is three threads less one way than the other, it can be accepted; if more than that, it cannot.

If the section of the unrubberized cotton cloth is declared according to the test pieces to be as ordered, the single pieces are to be marked in the following way:

The plain material is laid upon the table and every single piece is to be stamped with the stamp of the military aeronautical station with black oil colors on the extreme edge of both ends.

When the material is being rubberized the stamp is not to be covered, as it is at the end which serves for sewing the material onto the machine rollers.

Before the material is stamped it must be gone over to detect any breaks in the threads and weave knots.

If such defects are numerous and the strength and closeness of the material seems to be lessened by it, the material in question is not to be stamped.

During the stamping of the plain material a commissioned officer must be present.

If the cutting and sewing of the balloon is not done in a military aeronautical station, but in a private establishment, the rubberized balloon cloth after it has been examined and finished must be marked with a similar stamp if found to be up to the standard. But this is placed in the middle of the cloth about 5 meters distant from the end. For stamping, only such dyes as are non-injurious to the cloth are used.

Test pieces of the various completed rubberized cloths are to be tested by the various apparatus to see if they are gas proof and what their tearing resistance is.

In case one or the other of the pieces is not up to the standard so that their use for the balloon seems impracticable, they must not be accepted.

It is of great importance to examine the cloth to see that the material is uniformly vulcanized and of a sufficient strength at both ends. This is done by dabbing a spot several times with benzine; if it becomes sticky, it has not been sufficiently vulcanized.

A certain amount of experience and practice are necessary for judging the right grade of vulcanization.

Repairing the Balloon Material

This depends upon the way the material was handled in the first place during the time of use, second in the time before and during the storage.

Use. For spreading out the envelope and net for inflation, the cloth must not be pulled away harder than is absolutely necessary and without great tugging on the net. Stepping on the envelope must be avoided, and when it is necessary the men must take their shoes off or put felt coverings over them so as to lessen the damage.

The cloth of the envelope as well as the net is injured most by pulling it over the ground, because the material is rubbed off and becomes dirty very easily. If it should become wet, which is much worse, the cloth must be cleaned, as moisture is injurious.

Car. The same holds true for the car, which must always be carried and not dragged over the ground, because this would injure the wicker work as well as the ropes. The examining and repairing of the car ropes fastened in the wicker-work is very difficult.

Sand Bags. Sand bags must never be filled for any longer time than is necessary, and they are to be kept dry.

The filled bags must always be carried and never dragged along the ground, and when they are taken out of the net or from a higher place, they are to be carefully placed on the ground, but are never to be let fall.

No more bags than are absolutely necessary should be hung in the net meshes, as that causes the weaker ropes to tear. Care must be taken that the bags are evenly distributed around the entire circumference of the net. The men must seize the net evenly and at the same time all around. If one is a little bit slow an uneven distribution of the net meshes over the envelope results, which puts a strain upon the net and even causes a dangerous stretching.

The perfect functioning of the crow-feet lacings must be carefully seen to, as these keep the traction of the weights on the end lines the same on all meshes.

The Mooring Rope. The mooring must never either during the laying out or the pulling in be pulled over stony, wet, or sandy ground, as this causes the zinc of the wire to rust. Dampness between the wires not only causes rust, but gradually destroys the insulation of the telephone wire. Dust is also to be avoided, as it causes a friction rub between the wires and cannot be gotten out, even by careful cleaning.

When laying out the rope, dragging and twisting are to be avoided, as this might cause the rope, during the stretching, to tear at any place.

The kinking of the rope or the single cord is dangerous, as the rope rubs off very quickly at such places, and the telephone connection is broken.

When fastening the rope, the clamp must be fastened

in the traction direction of the rope, without any force, as the rope could rub through very easily on its edges. Should the rope be fastened by pulling it around some heavy or firm object, care must be taken that the slings are not twisted too severely and that they do not lie upon an edge. For this reason only large trees or round stakes of large diameter should be used.

Rope Drums. Clamps. Pulleys. In using rope drums, care is to be taken that they run smoothly; the bearings are to be lightly fastened, and if necessary, oiled. The clamps for the telephone wire are to be kept free, and like the sliding contact, to be free from oil.

Rope clamps are to be protected from dampness and dust during use, by placing wood or straw underneath, and dust or sand must never be used for increasing friction rubbing, but powdered rosin is to be sprinkled between the leather packings. The rope pulleys are to be treated the same way and are to be well oiled. They must be watched during use to prevent the rope from coming out of the socket and guiding arm, so that the splint or the friction nut of the roll axle will not become loose.

Instruments. The instruments and apparatus which constitute the equipment of the car must be handled according to their purpose.

Aneroids and telephone cases are most injured by dust and dampness, and must therefore never be packed in empty sand bags; they should never be disturbed unnecessarily. The instruments and apparatus must be taken apart by a mechanic only. The separate parts, such as springs, screws, etc., are never to be loosened or cleaned.

Handling during Use and during Storage

All the material is to be carefully examined, and if necessary, repaired after its use. It must never be put away in an imperfect condition, but must be kept ready for use at any time. In case of long storage all separate parts are to be carefully cleaned and carefully arranged.

The Envelope. The envelope must be thoroughly aired by partial inflation of air, which is to be repeated several times. When all signs of gas have disappeared, the material is to be examined and any necessary repairs made. In case of poor light or dark rubberization, only electric lights are to be used.

Care is to be taken that the envelope be not soiled by the chemicals which have escaped during the inflation from the gas apparatus. Such spots are not visible at first, but show up later by making the rubberization darker, and have an injurious effect upon the envelope after it has been put away, not only at the spot, but the surrounding cloth and all such places as touch it.

Such defects can be discovered through the difference in color or through testing with blue litmus paper, and must be neutralized with ammonia. In case decomposition has set in, it is best to cut the entire affected area out. A mere patch of repairing material must never be cemented over it. The same holds true for the net.

Balloon Cloth. In case all the finished rubberized material is not to be used at one time, but stored for a longer time, it must be rolled up. The single rolls are to be packed in air-tight boxes in a vertical position and are to be examined every three months.

It is not wise to have too much material prepared at the same time, as the slightest entrance of air hastens the oxidation and the corroding of the rubberization.

In case it is necessary to place several envelopes on top of one another, the positions of these must be changed occasionally.

Nets. The nets should be carefully dried and dusted, even washed, by taking up the single meshes slowly and carefully, and should be folded in the long way.

All repairs should be made immediately, or at least all injured places should be marked with a colored band to be repaired later. The net must be tied in various places by short cords and must be stretched the long way upon a table or a bench, or hung up on wooden pegs—never iron ones. Care is to be taken that no mice can reach it. This holds for all the rope work.

Rope Work. Heavier cords and ropes must be rubbed with tallow before storing. They are coiled, tied, and hung up on wooden pegs, or placed separately, but never on the bare ground.

The Mooring Rope. The mooring ropes are to be rubbed dry, cleaned of all dust, and protected from rusting by greasing the upper surface slightly. Rusty spots in all metals are to be carefully removed, but care is to be taken that no petroleum or grease spots get between the cords into the insulation of the telephone wires. The mooring ropes are to be rolled up on their respective drums. Short pieces of rope (cross rope of the kite balloon) are hung up without rolling. The tail contact must be taken off the rope drum and the brake loosened.

Valves. The valves, with the exception of those of the

kite balloon, are to be taken out of the envelope for cleaning, and after the spiral springs have been removed, they are to be hung up so that the rubber packing is free and so that the valve disk cannot lose its shape.

Rubber Articles. Articles made of rubber, as washers, packing hose, etc., are best prevented from becoming hard and brittle by rubbing them off several times with ammonia water. They must never lie next to metal, because this is injured by the sulphur composition of the rubber.

The Para rubber fluid can be stored only in sealed tin boxes.

Conditions in the Storing Depot. The storing depot must be airy and dry, and if possible, free from dust. It is also important that the temperature should always be the same, as the rubberization of the material is injured by changing temperatures. The windows of the depot are to be painted yellow, or to be draped with yellow cloth.

The varnished material is much more susceptible to changes of temperature. If the temperature is over 30° C. the varnish becomes sticky, while below zero it becomes brittle and cracks.

If the balloon cloth becomes stiff and cold, it indicates either poor vulcanization of the rubber, or that the envelope has absorbed moisture which has frozen. Before it is spread out or used, it must be thawed until the cloth is again pliable.

The stored balloon material is to be aired every month in favorable weather.

CHAPTER VIII

Materials Used

The cotton material is smoothly and closely woven, of a linen consistency, which is made of strong thread in warp and weft, both threads being of the same strength. The smooth upper layer insures even wearing and long endurance; the closeness of the weaving makes it gas tight by use of a small amount of impregnating material, be it rubber or varnish.

The weight of the plain material is based upon the quality and the weight of the impregnating material, especially in varnished envelopes, so that the weight of the finished envelope cloth governs its strength.

The firmness of the material in both directions is of prime importance.

Double diagonal-ply rubber cloth is difficult to tear, while a single-ply cloth tears easily. By constructing the envelope in the proper way the length of a tear can be held at a minimum.

Strength of the Plain Material. In examining samples of material, a section is taken and tested in the following ways:

A drawn thread is examined under the microscope to determine its fiber. Cotton fibers are easily distinguished from the others. The fact that they are substitutes is of less importance than that of quality and that

so-called "dead threads" exist, as these have very little strength.

With the naked eye one can judge the strength by the length of the fiber in the unraveled thread; it can be further tested by weighing it in grams upon a feather or thread scale. This test can be made only in a laboratory and hence is seldom used. The other examinations are more easily made and are quite satisfactory.

In order to determine the strength the cloth is placed under a magnifying apparatus (thread counter), the dropped threads per 1 cm. in both directions giving the uniformity of the weaving.

Loosely woven cloth often appears firm even if held against the light, because it has been prepared with starch or rubber, which covers the space between the threads. After this has been removed its open texture will be evident.

By weighing the material of a certain area the weight per square meter can easily be obtained.

Further tests serve to determine the strength of the cloth against tearing. For this purpose dynamometers are used, which are constructed after the following principle:

The fabric, cord, or crushed material is fastened into two slides which are secured by means of clamps to a horizontal or vertical frame.

One slide is connected with a dynamometer spring, while the other can be set in motion along a screw which is turned by a hand crank. When the slide travels along the screw it causes the spring which is connected to the other slide to stretch; this operates the hand of the dial which indicates the strength of the cloth.

When the strip tears, the spring returns to its original position and the pointer remains at its highest point. In order to compare the strength of different materials, the testing pieces must be cut the same size and shape. The pieces are cut 5 cm. wide; as the distance from the side of one clamp to the other is 16 cm., as much material as is required for fastening is allowed in the length, and that is to be marked by pencil marks. The pieces are cut a trifle larger in order to allow for the pulling out of the supernumerary threads and so finally to obtain the necessary width. It can be done more accurately by counting out the threads of a similar width.

The fastening of the strip must be done very carefully, so that the clamp stands perpendicularly to the length of the fibers. Then the strip is stretched lightly, on both sides, into the clamps, which grip the strip outside the pencil mark. One clamp is then tightened by turning the screw. The strip is then pulled out from the other, by lightly rubbing, until the pencil mark is visible.

Testing several times the clamps will be placed the correct distance apart and parallel to the pencil marks.

The balloon materials used for rubberized balloons show the following strengths:

in warp, about 40 kg.,
in weft, about 37 kg.,
in warp, about 25 kg.,
in weft, about 20 kg.

Thus the strengths of these materials are 800 kg., 740 kg., 500 kg., and 400 kg., respectively.

Numerous mathematical calculations can be made to

ascertain the firmness. An expansion of 5 to 15 per cent of the length is to be expected before it tears. The moment of tearing must take place at all points of the cross-section at the same time; if the thread pulls through in steps it indicates a poor weave.

Poor material does not tear off by fits and starts, but by gradually falling apart, when the fiber of the threads pulls out and the tear is fringed.

A good tear is straight and short, those in the direction of the warp being always of greater signifiance than those in the weft. Minor distinctions are of no account in the value of the goods.

All materials for rubberized or varnished envelopes are used in an unbleached, washed condition. Bleached materials are not used, less because of the difficulty in detecting faults hidden by the bleaching process than because rubberizing dyes them or they become dark colored when varnished.

Dyes. The rubberized envelope is the only one which is to be dyed in double-plied material. The outer layer only is to be dyed.

The dyes give the goods a uniform color and lessen the chemical influence of the sun's rays upon the gutta-percha.

Experience has shown that the chemical conditions of the atmosphere and the injurious qualities of the carrying gas do more damage than the rays of the sun, but cannot be lessened by any dye. To lessen the force of the chemical light rays and the heat rays we can use light-colored material, between yellow-green and yellow-red.

Until now, the material has been dyed either with a

heavy mineral dye—chrome yellow—or with aniline yellow. The first can be easily recognized by the trace of the red, the latter by the green.

The chrome yellow has the advantage of having greater durability. It prevents the drawing of water through the material and hinders, if only a little, the vulcanizing of the rubber, and becomes then on account of its sulphide of lead composition, a dark green or gray.

The aniline dye is not permanent, causes the material to draw water, rather than preventing it, and after a short time bleaches out entirely in the sun.

The black rubberization takes both kinds of dye well, the white rubberization only the aniline dye without changing color. This changing color is an excellent means of control for a perfect vulcanization of white rubber. For these reasons the aniline dyes are preferred.

After the above-named purposes of the dyes are considered, it is of no consequence if the material is light yellow or gray, as its appearance is no worse than the yellow dyes, which soon become dirty.

The aniline dyes are to be preferred to the chrome yellow. They offer the greatest advantage and last longer.

Preparation of the Rubberized Balloon Cloth and Envelopes

Rubberization of the Cloth. The material decided upon, and which has been previously dyed, is rubberized in the factory with a thin coating of gutta percha. This is done by a calender, the material being placed between the rolls and a stiff composition of Para rubber and naphtha then applied by spreaders, the latter being so placed

against each other that a very thin coating of gutta percha remains on the material; after the spreader has passed over it, it is dried on a long table kept warm by steam. These applications are repeated until the desired thickness of the rubberization is obtained. Each time the spreaders must be placed further apart. It is best to go over it several times, so as to obtain an even distribution of the rubber.

If one-ply material is to be rubberized, the entire gutta percha is to be applied upon it, but if double-plied material is used, half of the gutta percha is placed on one ply, and the remainder on the other ply.

In order to obtain one united piece of material the two pieces are put with the rubberized side toward the inside of the calender roller, and through pressure the rubberized sides adhere and the material is flattened out on both sides.

The manufacture of double diagonal cloth is more difficult, as most of it has to be done by hand. For this the material, not dyed on the inner side, is cut along the length in rhomboidal pieces with a slope of 45° and along the width of the upper material.

These are then placed and stuck on by hand to the rubberized side of the upper material of the outer cloth, so that the whole area is covered evenly with pieces of the inner material, which must overlap a little and lie exactly parallel to each other. The double cloth is then run through a calender to make it smooth and to insure a perfect union.

During this process the material is wound off by wooden rollers and then wound up again in order to prevent folds

or a smearing of the material. The material is always made in bolts of about 30 meters length.

Vulcanizing the Rubberization. All rubberized cloth, be it single or double plied (with the exception of the single ply used for repairing or gas-proof purposes), must go through the process of vulcanization.

The vulcanization makes the applied rubber—which in its present condition is still elastic, therefore soft, plastic and not resistant, and which would become hard, brittle, and lose its consistency when exposed to the air—less susceptible to injury through atmosphere or temperature.

For this purpose fine powdered sulphur is thoroughly mixed with the solution of Para rubber and naphtha and this mixture is then run over the cloth.

The vulcanizing process follows: The rubber is kept under heavy pressure and at a temperature of about 140° C. The sticky and plastic mixture, in which the sulphur can easily be distinguished, is changed into an even, transparent, horny mass, which is very elastic and resistant, is air and water proof, and resistant to mild acids.

The vulcanized rubber does not become brittle in the cold and has a longer resistance to the oxidizing influence of the atmosphere.

The vulcanization of rubberized material on rolls takes longer and is more difficult than that of massive objects of rubber. The heat penetrates slowly and unevenly into the bolt and heavy pressure cannot be obtained.

Such material is best vulcanized in a closed kettle, in which there is a steam pressure of four to five atmospheres for several hours and at the same time a temperature of about 140° C. Previous to this, the material is rolled

upon hollow metal rollers and wound around with waste material until the latter causes pressure upon the bolt of material.

It is impossible to obtain a perfectly even material, as the inner layers of the bolt are not so completely vulcanized as the outer. This is noticeable later on the single panels of the completed envelope, which wear out quicker. Some of the bolts of material made at the same time are imperfect, but that cannot be helped, as there is no better method.

Besides this system of vulcanizing, which is called vulcanizing by heat, there are several others.

There is a cold vulcanization, which is used for the so-called patent rubber goods.

For this the pure Para rubber (without sulphur) is combined with a fluid called chloride of sulphur, by means of steam, which gives an ineffective, evanescent sulphurization of the rubber.

Since this process must be followed by steaming, combined with a treatment by muriatic acid, the material is weakened more or less and cannot be used for balloon cloth.

Cold vulcanization of rubber (patent rubber) is much less serviceable and the upper surface becomes very brittle and hard when exposed to cold. The material vulcanized in that way must afterward be freed of the muriatic acid.

Examination of the rubberized balloon cloth consists of:

1. The test of the weight of the rubber.
2. Examination of the vulcanization of the close layers.

3. Strength of the material.
4. Gas tightness.

The Weight of the Rubberization. In order to determine the weight of the rubberization, one must first know the weight of the cloth when dyed; after taking the weight of the material (in double-ply material the weight of the outer and inner layer) from the weight of the finished product, the remaining weight is that of rubber, which is then judged by the unit area.

On account of the uneven distribution of the rubber on the entire length of the cloth, and on account of the small amount of rubber that is used, one must in order to obtain close data weigh several pieces from the same bolt and then determine the result mathematically.

In the rubber factories the necessary amount of rubber is weighed off and then run back and forth on the length of the cloth through the calender with the rolls a certain width apart until it has all been used. It sometimes happens that, on account of this, there is more rubber on one end than on the other.

Small differences in weight are of no importance. For complete rubberization of cotton material 100 to 120 grams of rubber are required per square meter. For light, plain material the smaller quantity is sufficient. For the double material the larger quantity is used on account of the threads of cloth crossing so much, and therefore lessening the strength of the rubberization.

Cloth used for repairing and as gas-tight strips for the seams, which is usually used double on both sides of the envelope material, is sufficiently rubberized by using 50 to 60 g. of rubber per sq. m.

The weight of the layer of rubber indicates its thickness; 100 g. of rubber per sq. m. give a layer 0.1 mm. in thickness.

The weight cannot be judged by simply measuring the thickness, or vice versa, because during the application the rubber is pressed into the space between the threads of the weaving, so that it is not flat upon the goods, and would not have the same thickness on the cross threads as would be given by the calculation of the weight per sq. m.

The weighing of the non-vulcanized rubber cloth is not a reliable method for determining the weight of the rubber. The result obtained this way is always higher than after the vulcanization, because then the superfluous sulphur is removed by the continuous effect of the heat.

Examination of the Vulcanization. The vulcanized rubber is usually not soluble in the ordinary dissolving solution; it simply swells more or less and after drying is unchanged. In articles made of patent rubber and in rubber that has not been vulcanized by the hot vulcanization the swelling is excessive. The more thorough the vulcanization the less the swelling.

By soaking and moving the cloth in a dissolving solution the rubber of the unvulcanized cloth will come off entirely, and by allowing the solution to dry up it can easily be placed upon a slide and examined.

If the rubber layer can be perceived by the eye (one-side rubberized plain goods) a magnifying glass will distinguish to some extent, the free, meal-formed sulphur in the rubber of the vulcanized cloth.

Strength. The test for the strength of the rubberized

balloon cloth, is made by the tearing machine. For this, several testing pieces are to be examined in both directions, because there will be a greater difference than in the plain material.

If the material is pulled through too closely placed spreaders, it is injured, as the fibers and the cross fibers are severely crushed.

The cloth is sometimes burnt by the heat of the vulcanizing process and the surplus sulphur. This is in itself unavoidable, yet by careful manufacture the strength of the cloth is insignificantly lessened, especially in double cloth.

The strength of straight double-ply cloth is almost equal to the sum of the two pieces in either thread direction. In comparison, the strength of the diagonal double-ply cloth is only the strength of the stronger of the two.

Testing the Gas Tightness. For examining the imperviousness of the rubber layers, as also of all the material used to make the cloth tight, for example, of varnished material, one can, as long as the mechanical resistance of the tightness is to be considered, use the following apparatus.

The so-called (bursting) tearing apparatus, Fig. 28, consists of a small cylinder, closed at the bottom, and a strong projecting rimmed vessel *G*, of a certain area, for example 100 sq. cm. over the opening. A stretching ring *R*, is hammered on and is fastened to the opening by a screw clamp *Z*, so that the piece of balloon cloth which is laid between is stretched over the vessel, and is shut off air tight. The cloth can be tightened from the inside by a slowly increased air-pressure.

For sending the required amount of pressure there is a hollowed three-way connection, *d*, on the side of the cylinder, which can be fastened with a strong hose to a pressure pump or to a mixed hydrogen-filled gas tank and a manometer *M*.

A gradual increased pressure inside the vessel can be obtained easily by being careful in opening of the tank valve. This pressure is read on the manometer, and then

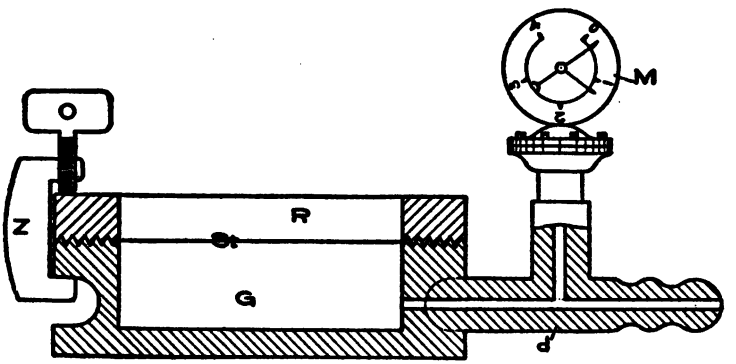


FIG. 28.—Test for Fabric.

the strength of the cloth can be judged. The cloth, in contrast with the bursting machine, is strained in all directions at once, because it is bulged up under the pressure.

The stretching ring has a high ridge; one can pour water upon the cloth, which shows rising air bubbles the moment the rubberization becomes loose. The dead pointer *T* on the manometer finally registers the pressure under which the cloth gave way.

It is not difficult to tell from these two pressure heights, and from the amount of the bulging of the material, in

connection with the results of the tearing apparatus test, the ultimate expansion, when the material loses its strength and becomes useless.

In these tests the pure mechanical density of the balloon fabric varies visibly upon examination, because of the transparency of the thick layer caused by the gas diffusion. From this standpoint there is no absolutely firm material, but there are some of a higher grade than rubber, for instance, varnish and goldbeaters' skin.

Even without pressure in the balloon, which strains the envelope, the gas would escape through the envelope.

The speed of the diffusion depends entirely upon the gas pressure, the nature of the gas, the thickness of the rubberization and the size of the balloon.

In order to determine it, a simple apparatus, Fig. 29, is used, whose principles are as follows:

If pure hydrogen is put into a gas-proof cylindrical vessel, whose cover is formed by a stretched piece of balloon cloth of a certain area, the vessel being closed by a movable liquid cork in a manometer tube, the moving of the liquid cork will show conclusively that the gas escapes through the meshes of the cloth.

If the manometer is calibrated and graduated into volumes, it is possible in a certain length of time, through the gas escaping through the cloth, reduced according to the area of the cloth, to determine the firmness of the cloth in a completed balloon.

The amount of diffused gas so added should really, in order to determine the diffusion into the inner part of the balloon, be increased, after a certain physical rule, by an equivalent amount of air, when it is desired to compare

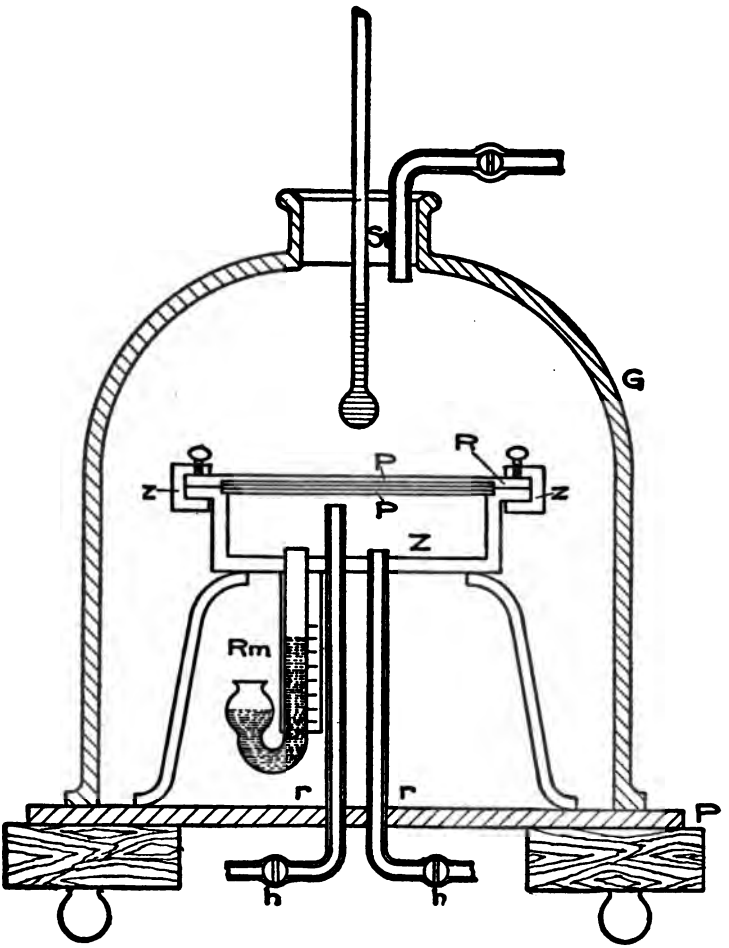


FIG. 29.—Test for Diffusion.

the amount of escaping gas to the carrying capacity of the balloon, but this in general can be passed over on account of the small difference and because with mixed and illuminating gas it cannot be estimated easily.

For comparing the different goods, the results from the observation of the changing volumes are sufficient.

The apparatus consists of a brass cylinder *Z*, with a firm floor, a covering ring *R*, hammered upon its upper projecting rim of 100 sq. cm. area, and two porous circular plates of clay *P*, of which one is placed in the opening of the cylinder and the other in the ring. The cloth is laid over the opening of the cylinder and after setting up and stretching the ring with the screw clamp *Z* to the vessel, making it gas tight, is pressed lightly between the two plates. This serves the purpose of preventing the change of volume of the shut-off gas in the vessel, when the cloth gives way under increasing inside or outside pressure.

For keeping out disturbing influences of the changing temperature in the air of the testing space, the vessel is under a large glass bell *G*, gas tight, which rests upon a glass plate and is fitted up with a glass plug *St*, so that only the manometer tube *Rm* is in the inner part of the bell. The tubes introducing and expelling the gas stand out from below the glass plate *P* and can be opened and closed as desired through the gas cocks *h*.

The test is made as follows:

After the cloth has been stretched out between the clay plates and the ring, and the rim of the vessel has been slightly greased, a certain amount of fluid such as vaseline oil or glycerine is poured into the manometer tube.

Then the bell is erected, but its plug must be taken out, so that air can pass in and out easily.

From a hydrogen-gas apparatus the purest and dryest hydrogen is led through the inlet pipe into the vessel, and then let out by the discharging pipe, until the interior of the cylinder is filled with pure gas, whereupon the gas cocks are turned off.

The gas is turned off at a certain excess pressure, so that if the fluid in the manometer originally stood at the zero mark, it is pressed down somewhat more than half of the length of the scale, when the bell is closed with the plug and the time is measured from the moment the fluid in the manometer moves from $\frac{1}{2}$ c.c. below zero until it has reached $\frac{1}{2}$ c.c. above o.

From this time, the height of the diffused gas volume (1 c.c.) and the area of the cloth being tested (100 sq. cm.), one can easily figure the escape of gas per sq. m. and per unit of time, for example per day or hour, and can compare the gas tightness with that of other materials.

The vessel is to be refilled with fresh hydrogen several times during each measurement.

Examination of Varnished Material. The same rules for examining rubberized balloon cloth apply to the examination of varnished goods.

Construction of the Balloon Envelope out of the Rubberized Cloth

Varnished goods cannot give such a strong resistance to the further tearing in injured places as the diagonal double-ply rubber goods, with gores set together out of

small pieces, to limit the tear to the smallest space by a seam, which is very hard to tear.

In general, to assure the security of the envelope against the sudden increasing internal gas pressure, the seams are to be so arranged during the construction of the balloon that they cross as little as possible.

In a spherical-shaped envelope they all run either in parallel circles, or, what is still more serviceable, in meridians, whence the elasticity of the material in the direction of the seam, on account of its stiffness, is lessened; but it can at least be expanded to its full extent in the perpendicular direction.

In order partly to obtain this desideratum in varnished envelopes, in spite of the seams running in both directions, the small pieces are best put together like a chess board, so that only the vertical running seams come together in the meridional line, while those running in the direction of the parallel circle form small connecting lines.

The wider the gores are set on the equator of the envelope the less the number of seams needed, which not only make the cutting and putting together easier, but lessens the weight of the envelope considerably. This is a much desired factor, because the rubberized material itself is heavy, and the seams, on account of having to be finished on both sides, add to its weight.

Patterns and Cutting Out the Gores. The gores are marked on the cloth after a pattern, and are then cut out. The patterns are drawn upon heavy paper (also cardboard) after any certain construction method, and after cutting, an allowance of 1.5 to 2.5 cm. for seams is made on one side.

Along the length of both boundary lines of each gore marks are made at certain distances from the ends of the pattern. These are guiding marks for the purpose of properly fitting together the different pieces of material, and preventing injurious stretching of the goods.

The marks on the inner lines of the seam strips also form boundary lines for the gores when the patterns are to be marked on the cloth.

The width of the pattern in comparison to that of the goods must always be so much smaller that the first can be marked over on the spread-out and evenly stretched material in such a way that the points of the ends are not in the middle of the material, but lie diagonally against the edges. In this way very much material is saved, as there is little waste, and the gores can overlap one another quite a distance.

It must be mentioned that the various gores are drawn sloping in the same direction, so that a stretching between the single parts of the envelope does not occur.

The work on the rubberized envelope begins with the cutting of the various gores and other parts. Then the putting together of the envelope is begun.

Putting the Envelope Together. For gluing together, a stiff solution of rubber is put on, evenly thin, with a brush, or better still with a spreader, over the sides of both pieces that are to come together. The two gores are spread over one another, the width of the seam strip of the lower projecting beyond the upper (as book-binders do when they paint over several pieces of paper) so that one can cover at the same time the upper surface of

the gore and the under surface of the other with one stroke.

After the rubber is dry, the two gores are pressed together. Care should be taken to stay within the given boundary marks.

By going over the surface several times with an iron roller made for this purpose, a secure union is obtained.

It depends on circumstances whether one sews up the seams—two parallel quilting seams—after the gluing each time, or waits until a larger number of gores have been glued together and sews them at one time. This is decided by convenience and the condition of the sewing machine, whose arm's length and height allow only a certain amount of goods to go through at a time.

The final seam of the envelope is the most difficult, but since the slit on the ripping panel is still open, the work can with care be done quickly.

The best arrangement for gaining time is to glue and sew as well as finish the seams at the same time. The gores are glued together and sewed first in pairs, then in fours, in eights, etc.

The gores are to be set together on the equator and must have each half of the balloon finished separately when the equator seam is finally sewed on. For this the two halves are placed on one another, glued and sewed, for such a length that it is still possible to pull the strip through the sewing machine.

The final seam can be sewed only through the ripping panel. The slit of the ripping panel is closed by turning the edges around, brought to the outside, not inside, and stretched for 1 cm., and is reinforced at both ends by

a strong piece glued and sewed on to prevent tearing. The seams of the ripping panel are not to be finished, but if it is done, then only from the outside.

Close stitching should not be used on all seams, as they weaken the cloth very much. A stitch 2 mm. long is very serviceable.

For completing the work on the envelope, reinforcements are usually glued on the upper third of the circular surface around the valve opening, and are cut out according to the gore pattern, and extend almost half a gore breadth from the valve. They reinforce that part of the envelope which has the greatest strain from the gas and prevent the net knots from rubbing through.

Finally the opening for the valve is reinforced with one or more layers of double cloth and then the hole for the valve is cut.

The appendix opening should be as wide as one-tenth of the diameter of the balloon. Small openings are dangerous and too large ones are of disadvantage on account of the escape of gas and polluting; but this can easily be remedied by longer appendix bags.

In order to prevent the rain from dropping into the car, a rain strip is placed on the lower part of the bag. It is made wide enough to shed rain outside the car.

The wooden appendix is an important factor in free balloons in attaining easy inflations, besides reinforcing the appendix opening of the envelope. It is fitted with rings to which appendix ropes can be attached.

The appendix ring is set in from the inside and is covered with leather on the outside and studded with nails. Since it forms a handle during the handling of the work, it is

necessary to glue a double piece 1.5 to 2 meters long around the appendix opening.

For tightening strips as well as for reinforcement unvulcanized cloth is used more than vulcanized, as it adheres better.

Para rubber is never spread upon the plain rubberized cloth, be this vulcanized or not, as it swells and is easily loosened from the material, and is made entirely soluble by the cementing material. Since such material is always to be cemented upon the cloth side of the balloon, the Para rubber is spread only on that side. Gas-proof strips are required in such numbers that it is necessary to cut them out upon a turning lathe from a whole bolt of cloth rolled up on wooden rollers.

For this the knife is dipped in water. The width of the strips is governed by the width of the seams.

Examination of the Completed Envelope. Every newly constructed envelope must be thoroughly examined before it is used. The ripping panel is closed for this purpose and the valve is set in. The envelope is inflated with air, whereby all big mistakes in the construction and expansion are easily seen. After the outside examination, it must be examined from the inside to observe the consistency of the cloth and the rubberization as well as to discover any mechanical injuries (stitches, cuts, friction rubbing and oil spots) and the tightness of the seams.

For night work or when the envelope is rubberized with dark rubber, or in case a light is needed, no light but an electric one is to be used. In hangars these are the only lamps permitted.

As soon as the edges of the ripping panel slits are injured

through use, there is danger of a difficult loosening of the strip. The ripping arrangements must then be placed upon another gore and the former one treated as though a large tear. When this is done, the changing of the mark of the ripping panel to the proper gore of the envelope must not be forgotten.

CHAPTER IX

The Spherical Captive Balloon. Equipment; Inflation, Anchoring, Ascension

Envelope. The spherical balloon (Plate II,) consists of the envelope *H*, the net *N*, the coupling ring *R*, and the car *K*.

The envelope is made of yellow rubberized cotton diagonal cloth and is put together in meridional gores.

The upper part is called the upper cap and the lower part is called the lower cap. Added to this is the appendix *F*, together with the appendix ring *Ar* and the rain strip *Rst*. The envelope is reinforced at the top of the upper cap and the top of the appendix by doubling the material.

At the top of the balloon a valve opening is cut.

The line of the greatest circumference perpendicular to the seams is called the Equator, *Equ*.

The Upper Valve. The upper valve closes the valve opening so that it is gas tight and consists of the following (Figs. 31, 32):

1. Upper valve ring *Vr2*.
2. Lower valve ring *Vr1*.
3. Valve disk with valve cord *L*.
4. Spring *F* and wing nut *S*.
5. The two packing rings made of rubber.
6. The three guide rods *Fst*.

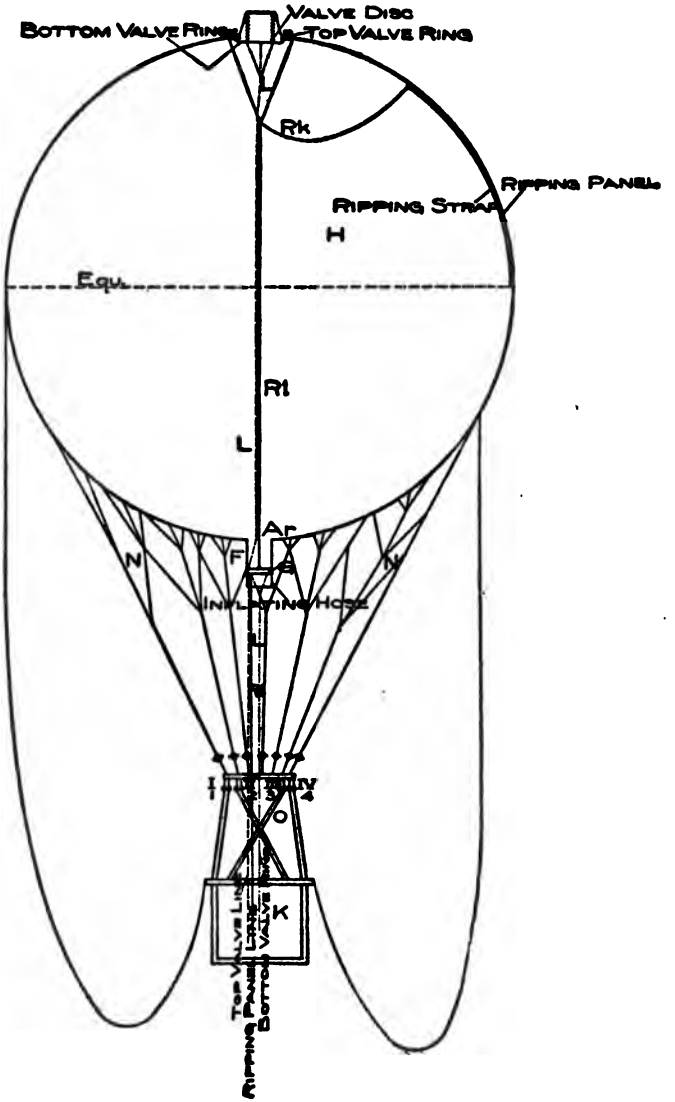


FIG. 30.—Spherical Balloon.

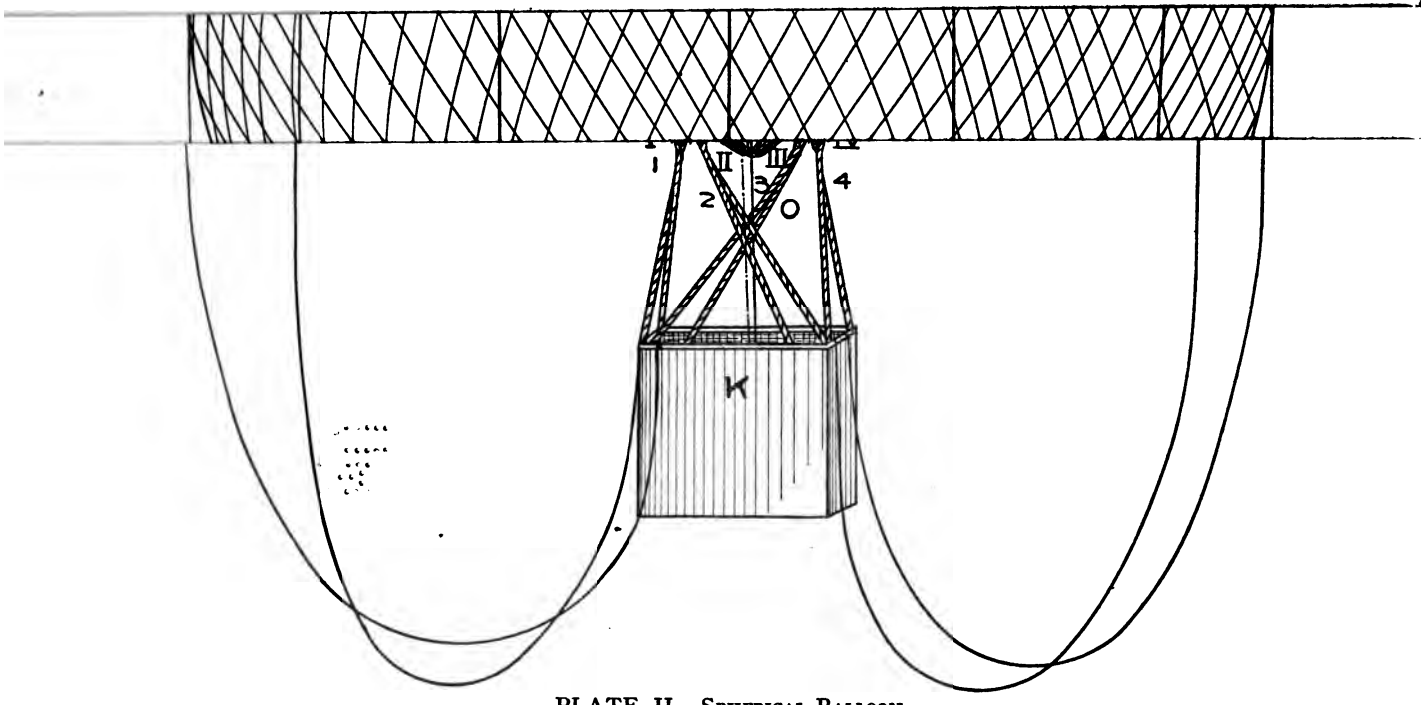


PLATE II.—SPHERICAL BALLOON.

(*To face page* 126)

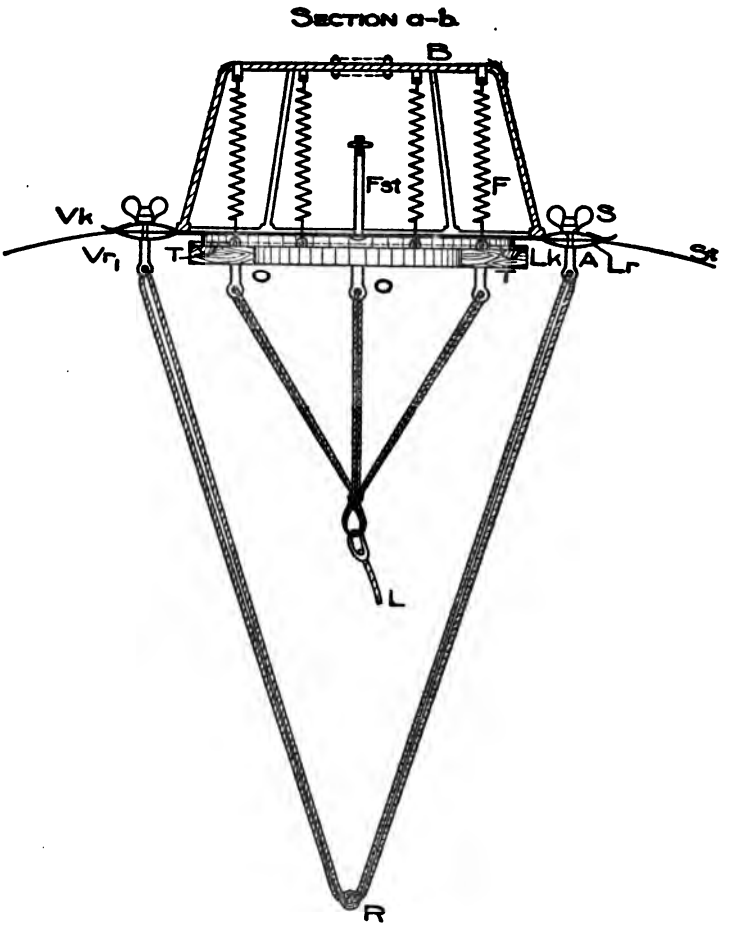


FIG. 31.—Upper Valve, Spherical Balloon.

The upper valve ring is made of bronze and consists of a valve ring *Vr2*, fitted with the screw holes, and the hoop frame *B* for the valve spring *F*.

The valve disk is a circular rim made of wood whose opening is covered with rubberized material. The gas-tight compartment is formed by means of the gutta percha

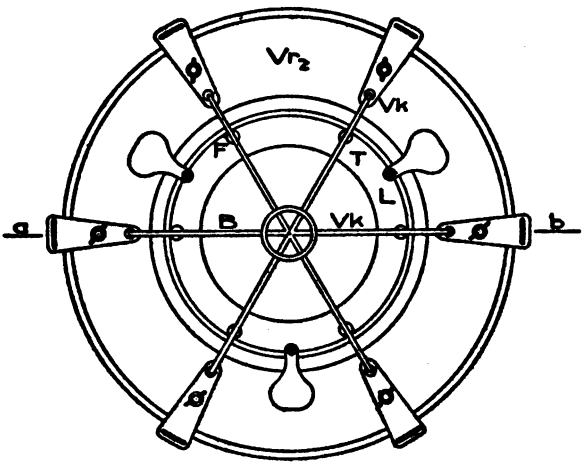


FIG. 32.—Upper Valve, Spherical Balloon.

washer *Dr*, having six valve springs pressed against the packing ring of the upper ring.

On the lower side of the valve disk three eyelets are fastened. A yellow-black valve rope is fastened into a loop which passes through the eyelet. The lower valve disk is made of bronze and is tightened by means of the thumb-screw toward the upper valve disk.

The material of the balloon *St* is placed between these two valve disks and held by means of thumbscrews. The

valve disks are made gas proof by means of packing rings. The lower valve disk has at its under side two eyelets *A* for the fastening of a coil with the loose loop *R*, to which is fastened the ripping lock bolt. Every valve has six

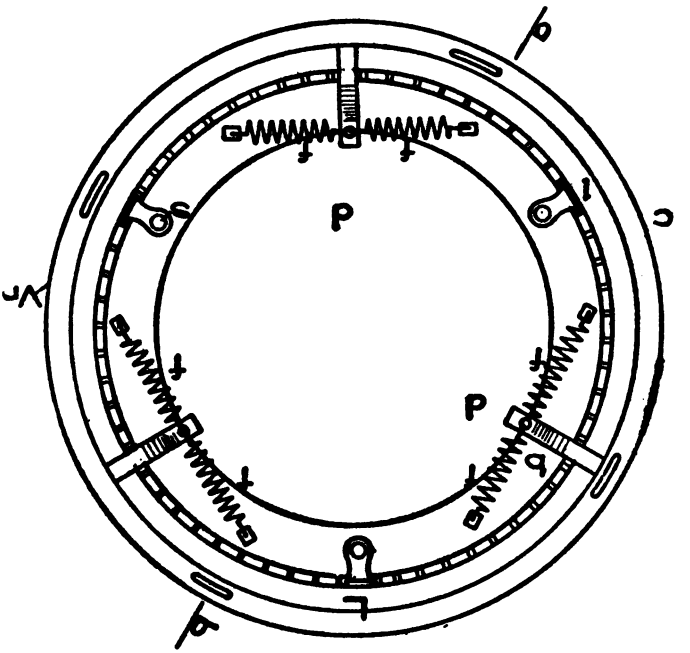


FIG. 33.—Lower Valve, Spherical Balloon.

springs, one end of which is fastened to the eye of the snap, the other into one of the screw bolts of the valve disk. They fasten the gutta percha washer of the valve disk to the packing ring of the upper valve ring.

To limit the motion of the valve, and to direct the valve disk while it is open, there are three guiding rods *Fst*,

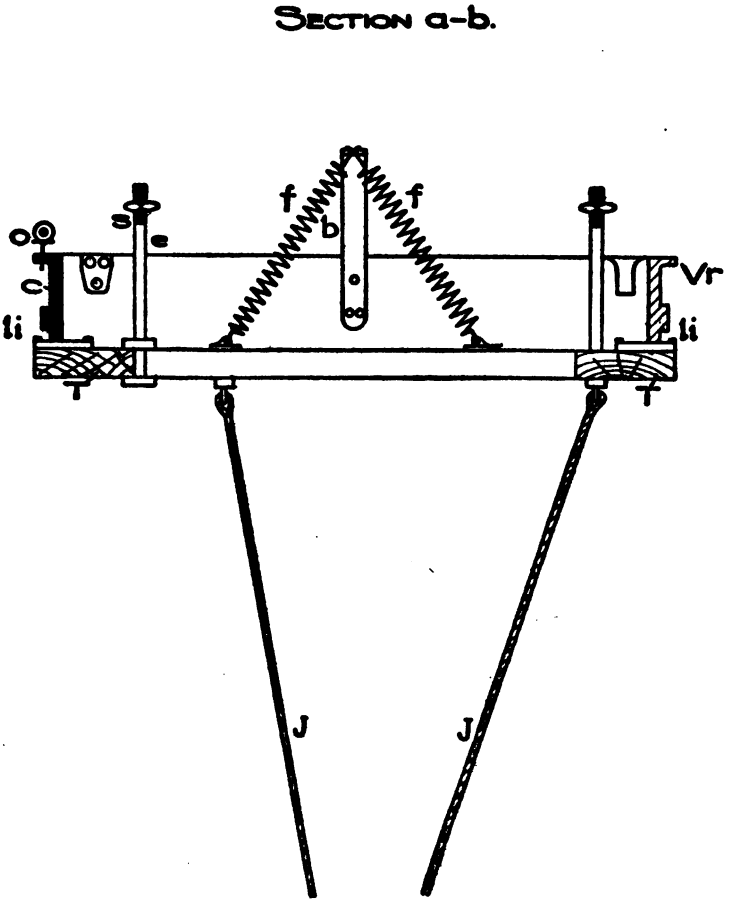


FIG. 34.—Lower Valve, Spherical Balloon.

secured by means of nuts. These guiding rods lead into the straps *L*, and pass through the wooden part of the valve disk holding the eyelets for the valve rope.

Lower Valve. The lower valve is also a disk valve. (Figs. 33, 34.) It is made up of the valve ring *Vr*, the valve disk *T*, the rubber packing ring *li*, six valve springs *f*, three guide rods *s*, three spring hoops and three guide straps *L*, and the lower valve rope *J*. The lower valve opens automatically when the gas pressure in the balloon has reached a certain height. It can be opened from the car by pulling on the valve rope.

The fastening of the lower valve in the appendix is

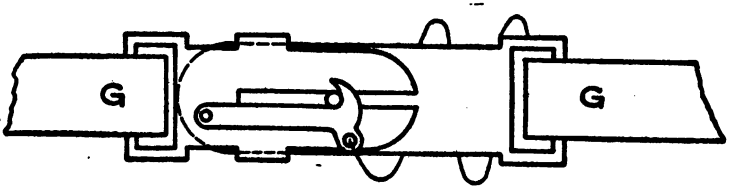


FIG. 35.—Fastening of Lower Valve.

obtained by means of a valve belt *G* (Fig. 35), together with the exchange mechanism and its cord.

In order to fasten the lower valve in the appendix it is pushed from underneath. The ripping rope and valve rope are to be led out between the appendix and the valve, so that these lines will lie upon the disk valve. On top of this the valve is to be fastened from the outside by means of the valve belt in such a way that the rope lies upon the easily bound nut at the circumference of the valve. The valve belt must be taut and the clamp must be put on in such a manner that in order to open it is only necessary to turn it down.

The exchange rope, which leads to the basket, is fastened onto this clamp. Several loops must be placed on the hook from underneath, between the belt and material, so that the hook will not open when pulled accidentally.

By pulling on the exchange rope, the lower valve is opened and falls out of the appendix. In order that the valve should not fall into the car, it is fastened by means of three cords to the eyelet of the ring in the appendix ring. The various parts of the valve are to be marked so as to make assembling easier.

The Ripping Arrangement. The ripping arrangement serves to deflate the balloon rapidly as an aid in landing, and consists of

The ripping seam,
The ripping panel,
The ripping line R_1 and latch RK (Fig. 30).

The ripping seam is a balloon gore which has a meridional slit of scant 3 cm., which reaches from the upper third of the envelope to the equator. The edges are seamed. The small slit-like opening is made gas tight by means of the glued-on ripping strip. The ripping strip is made of balloon cloth about 20 to 25 cm. wide. At the upper end of it there is a wooden toggle for the fastening of the ripping line. This serves for pulling off the ripping strip. The ripping line is a strong red band, which leads into the car and has a ripping lock bolt near its upper extremity. This ripping lock bolt prevents the too early opening of the ripping seam. On the lower cap of every free balloon the ripping seam must be marked with a black arrow.

The Appendix Ring. The appendix ring is made of wood and strengthens the upper part of the appendix. On its outer side there are several grooves for the fastening of the appendix ropes. Inside there are three grooves for fastening of the lower valve.

The appendix ropes are fastened in the car and serve the purpose of stopping the lower cap from swinging when the balloon is not completely inflated. The other ropes are carefully secured in order to prevent the lower valve from being pulled out of the appendix.

In a strong wind the appendix rope should not be pulled too tightly, as this would cause a serious swinging of the car and hinder observation.

The Net. The net connects the car to the envelope and serves as a fastening for the mooring rope onto the balloon. It is knotted together out of ramie-cord, and consists of the supporting net and the holding net.

The supporting net or short net is made of horizontal rows of rhomboidal mesh, which end as single lines on the bottom. At the top it ends in a net ring which is fastened into the eyelet of the upper disk valve by means of net straps.

The net is divided into three rows of lacings, the small, the medium, and the large. Onto the larger ones the end lines are fastened. They serve to connect the net with the ring and have at their free ends eyelets for taking up the toggle of the ring.

The holding net starts at about the middle third of the balloon and consists of three rows of lacings which end in twelve holding lines. They are distinguished from the end lines by a metal thimble at their ends,

through which the running line, which is 24 meters long, is pulled.

The mooring ring on the balloon consists of a steel pipe, covered with ramie cord, and having toggles at the top and bottom. On the upper side there are twelve toggles for fastening end lines, on the lower side four toggles for the car connection. There are four rope loops also fastened to the ring which connect to an iron ring. To this ring the rope clamp of the mooring cable is fastened.

The car is larger and held more securely than that of the kite balloon and is fastened to the ring by means of the car ropes. Plate II, Fig. 30. The short ropes lead from the narrower sides and the long ropes from the longer sides. These ropes, *O*, end in the leather-covered rope loops No. 1 to No. 4.

The suspension of the car by means of the car ropes is linear. The four toggles are arranged in two opposite diametral groups of two toggles each and serve for fastening the four car ropes.

The car is fastened onto ring *R*; the ropes of the narrower sides of the car are fastened directly, and those of the longer sides crossing each other into the opposite diametrical car toggle of the ring.

The equipment of the car is the same as that of the kite balloon except for the addition of the mooring ring.

Inflation of a Spherical Captive Balloon

The balloon is placed on the rectangular ground cloth so that the valve inlet is in the middle and the appendix ring end is turned toward the gas apparatus.

It is important to watch that neither the upper nor the

lower part of the material wrinkles, and that no wrinkles shut off the opening of the appendix. To prevent this the material must be laid in folds over the appendix ring so that one can see through the appendix into the envelope. Then a petty officer seizes the ripping and safety valve ropes, which have leather-covered ends, and leads them from the valve opening out through the balloon about 2 meters outside the appendix. Then he places the ripping rope in coils from the appendix ring in proximity to the valve opening, and fastens its upper end with ramie cord onto the toggle of the ripping panel, allowing the ring of the ripping cord to lie in the valve opening of the expanded envelope. Now the valve rope is laid in coils from the appendix ring to the valve opening. Therefore it is of great importance that the coils of both ropes should lie separately so as to prevent them from becoming entangled during the inflation.

The Valve. The setting in of the upper valve now follows. It is separated from the lower valve ring by unscrewing and loosening the wing nuts and the valve springs of the upper valve ring and the latch, which is fastened to it by means of ropes. This latch is also fastened onto the ring in the ripping line, so that the snap of the valve rope is snapped onto the rope loop of the valve disk. The valve ring and the valve disk with the rubber washer are led upward to the valve opening of the envelope, and the materials in which holes have been cut are placed over the screw bolt of the valve ring, whence the upper valve ring is connected with the lower valve ring by means of a butterfly screw; it is necessary to avoid catching material between the two valve rings.

The Net. One petty officer and twelve men of the balloon squad place the net so that the net ring encircles the valve. Then the men seize the end lines and spread the net; the officer stationed at the valve takes the net ring in his left hand and with his right seizes the upper net meshes as far up as the large crow-foot lacings, pushes the net over his head and has the men spread the end lines around the balloon, being careful that they are equal distances around the balloon. He now shoves the net ring over the valve and fastens it by means of a rope (net-fastening rope) which is fastened onto the upper valve ring. Care is necessary that the net meshes are evenly distributed between the ropes.

Now the command of "Lift the net" is given. The end lines are coiled and taken in the left hand upon the command of the petty officer of "Large, Medium, Small, Crow-foot lacings." The large, medium and small lacings are seized separately at the rings by the right hand and placed in the left.

Upon the further command of "One (two) meshes," the others are placed in like manner.

Upon the command of "Halt" that part of the net which is in the left hand is pushed under the balloon and the holding line is coiled and placed upon it, then the petty officer in charge sees that a full sand bag is hung in every third mesh and that the point of the hook is turned away from the balloon.

The Inflating Hose. The inflating hose is connected gas tight with the appendix of the balloon by means of a tin pipe and then the balloon is ready for inflating.

Inflation. During the inflation, care must be taken that

there are no folds in the cloth, and that the net is not pushed through uneven distribution.

The folds of the cloth can be evened out by means of pulling and shaking the cloth in the vicinity.

To prevent the net from being pushed crooked, it is necessary to see that the gas is evenly distributed and that the sand bags are hung in a mesh row so that these cause an even amount of tension.

The Lower Valve. After the inflation the lower valve is set in. It is next fastened to the corresponding grooves of the appendix ring by means of ramie cords; then it is pushed upward by the springs to the middle of the appendix after the valve and ripping ropes have been laid in coils upon the valve disk.

Then the elastic band with the point of the hook of the lock is swung upward around the valve from the outside, tautly stretched and closed. A ramie rope 10 meters long for loosening the band from the car is to be so fastened to the hook of the snap that several coils lie between the belt and the envelope to prevent an accidental loosening of the band lock. Then the ring is fastened onto the main line and three ascension ropes are fastened to it with a knot.

The Site of Anchoring. The anchoring place should be out of the range of firing of the enemy and also out of their sight. It is best to seek a place sheltered from the wind. The best places are roomy hollows, quarries, unused highways, and behind houses or groups of trees. On a flat unprotected plain, wagons or baggage can be placed upon the windward side after the earth is thrown up similar to a trench on that side in the direction of the wind. This is done in the shape of the balloon. The using of im-

provised balloon sheds and wooden walls on the windward side is of advantage.

The preparation of an anchoring place is the same as that of an inflating place. The balloon is to be anchored on the blanket in an uncoupled condition, fastened and weighed down by sand bags.

The Balloon Watch. A balloon watch must always be ready at the anchoring place, and have mallets, stakes, and ropes at hand.

Under normal weather conditions and when the balloon is anchored near its storing place, the watch should consist of at least one commander and three men. They must serve as a day and night guard.

Under unfavorable weather conditions and when the balloon is far away from its storing place the number of men is increased according to the judgment of the commander of the balloon squad, and an officer must stay with the balloon at all such times.

The watch should see that the following points are observed:

Under rising temperature and corresponding gas expansion the holding lines must be slackened. Under falling temperature the same lines must be tightened. It is best to dry the rope first in case it has become wet.

In anchoring during an increasing wind the anchorage is to be strengthened accordingly. Should the wind become so severe as to threaten to tear the balloon from the moorings, the officer at the balloon must, as a last resort, order the balloon to be cut open. This work is done by those men who are not at a given post. Salutes are not given during this work, but only after its completion.

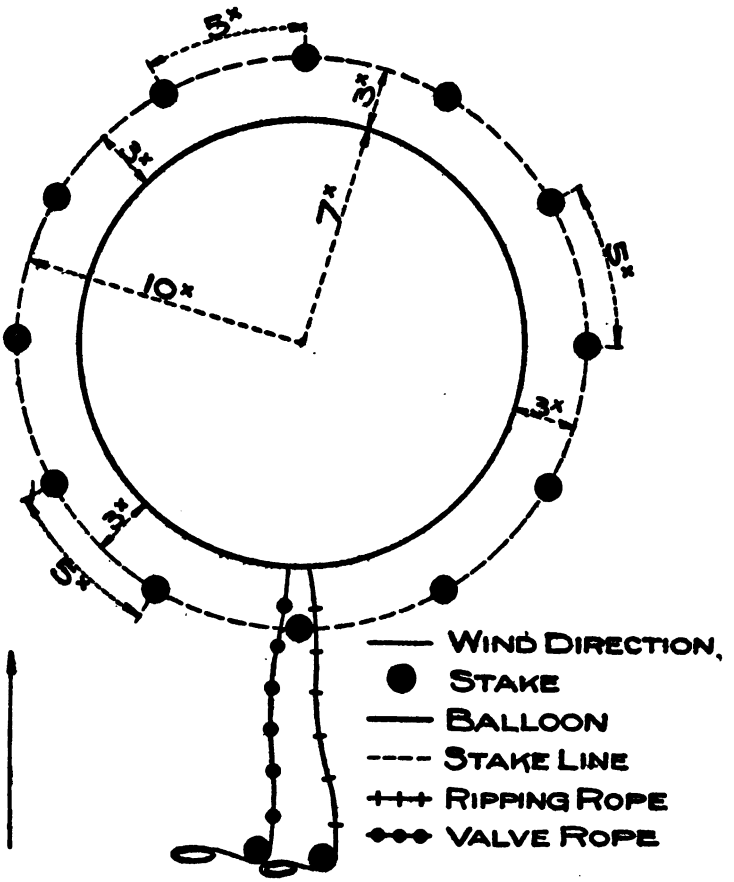


FIG. 36.—Anchoring of the Spherical Balloon.

The Anchoring of a Spherical Balloon

The anchoring of a spherical balloon (Fig. 36) consists of the following steps:

1. Laying out the mooring place by the car squad.
2. Stretching the rectangular blanket.
3. Transporting the uncoupled balloon onto the ground cloth, placing the ripping seam in the wind, weighing down the balloon by means of sand bags, and fastening the holding line onto the stakes by No. 1 of the balloon squad.
4. Fastening the ripping and valve lines onto two stakes which are on the side of the ripping seam.
5. Depositing the car and its equipment.

Preparations for Coupling. Upon the command of "Ready for service" the crew step up to the balloon (Fig. 37). In order to divide the crew the commander gives the command of "To the balloon." Whereupon the crew march to their places at the balloon. The balloon is held by the crow-foot lacings of the net meshes with both hands. Then upon the command of the balloon officer in charge the anchorage is lifted by the Nos. 1.

The three pieces of lengthening rope for the transport of the balloon are pulled down under the supervising petty officers and are held by the Nos. 6 of the balloon squads.

Ascension

The Car Squad. When the place of ascension is reached, the car and its equipment is placed with the short side in the direction of the wind and the crew advances as shown in Fig. 37.

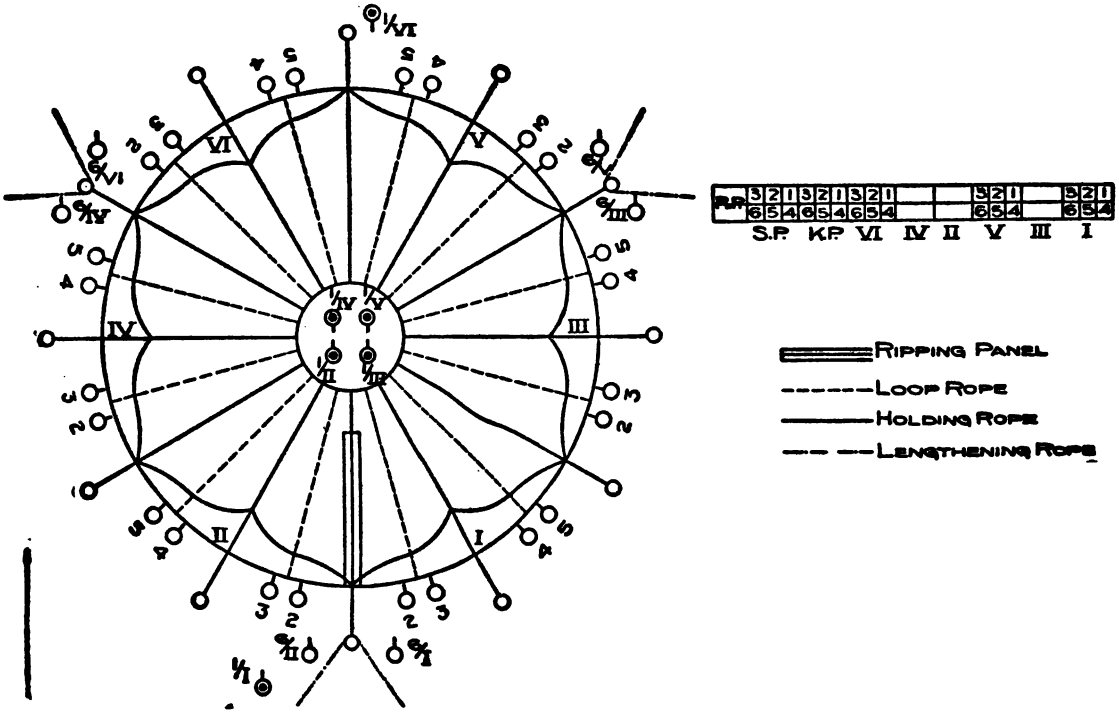


FIG. 37.—Preparation for Coupling, Spherical Balloon.

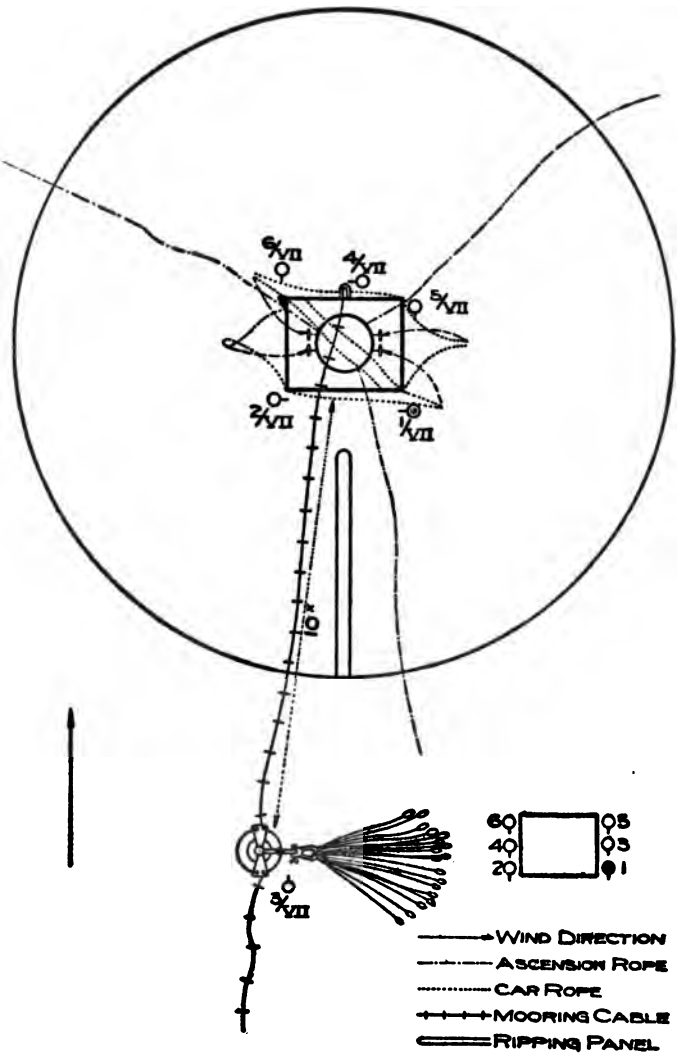


FIG. 38.—Ascension, Spherical Balloon.

Nos. 3 and 4 take the rope pulley and traction ropes out of the car and Nos. 1 and 6 lay the car ropes out on the ground and place them as shown in Fig. 38.

Then those numbers seize the long car ropes and exchange them in such a way that No. 1 takes the one handed him by No. 6 and pulls it through his own car rope under the eyelet. These numbers then fix the eyelets of the long car ropes into the car corners nearest them. This is in order to prevent a mistake during the coupling.

After the mooring cable has been fixed, No. 4 of the car squad takes the rope lock and places the end of the rope above the crossed car ropes which are over the car's rim.

The Rope and Reserve Squad. The work of this squad is similar to that of the kite balloon.

The Coupling. After the balloon has been placed over the car the officer in command orders the balloon placed in such a way that the ripping panel is over the side of the car toward the wind. Upon the command of " Small, medium, large crow-foot lacings," the balloon is gradually lifted so that the lower part of it can be handled; the end lines are to be held during this operation. Upon the command of " Coupling," Nos. 1 and 6 seize the rope eyelets of the short car ropes, which are lying on the ground, and fasten them into the left toggle of the ring procured for them by the car rope toggle group. Then they seize the rope eyelet of the outer car ropes and connect them with the free right car rope toggle.

No. 4 couples the rope lock, No. 5 lays out the ascension ropes.

In a strong wind and in order to relieve the men, sand bags can be placed on the end lines. This is done upon the

command "On the end lines." Then the crew advances, lifting the balloon higher on the end lines toward the ring; when the balloon arrives at the ring the command of "Halt" is given. Upon the command of "On the ring" No. 2 goes to the ring in order to strengthen the car squad. Upon the command of "On the ascension ropes," No. 1, then 3, 4, 5, 6, and 2 place themselves in two groups at one ascension rope. The ascension of the balloon is then permitted.

CHAPTER X

The Free Balloon Equipment. Preparation for Ascension. The Ascension

We may class any other balloon than the spherical as a free balloon.

Its size is governed by the capacity of the gas bag, the weight it can carry, the amount of material, and the time required in construction.

Rubber balloons which use hydrogen for inflating should have a volume of at least 600 cu. m., while those carrying illuminating gas must have a filling capacity of 1000 to 1300 cu. m.

The free balloon consists of an envelope, the valve, the ring, and the car.

In constructing the envelope the same cotton gutta-percha-lined cloth is used as in the captive balloon; or it can be made of silk.

The valve is constructed similarly to the upper valve of the kite balloon, except it is made lighter and bigger. The valve disk and the valve ring can also be made of wood.

There is no lower valve in a free balloon.

The Appendix Ring. The appendix ring is constructed like that of the captive balloon, and serves the purpose of keeping the appendix opening in place should the balloon fall, so that the functioning of the valve and ripping rope will not be impaired. By fastening the appendix rope to a

sling attached to the car it prevents the car from turning over completely when landing.

The Net. The net of the free balloon usually has only two rows of crow-foot lacings and twenty-four end lines.

The holding net is not necessary.

In case of a scarcity of nets a belt with the end lines can be sewed onto the equator to take its place.

In free balloons, on account of their very light weight, wooden rings are used. If these are not at hand, rings made of gas piping or iron rings can be used, which are covered with the same cordage covering so that the toggles cannot move out of place.

The wooden rings are firm on account of a right-angle cross brace. Safety rope rings are placed in grooves at the upper and lower rims of the ring.

The ring of the free balloon has twelve or twenty-four small toggles for the coupling of the end lines, and eight or twelve large toggles which are evenly distributed around the ring for the coupling of the car. For the fastening of the tow rope to the ring there is a toggle.

The Car. The car is similar to that of the spherical captive balloon, only does not have a lineal suspension, but is fastened to the ring by means of eight or twelve, and in large balloons, with more ropes ending in eyelets. The car ropes are woven into the car and the sides of the car are not pierced.

The Landing. The landing mechanism of a free balloon consists of the valve and ripping panel with the guide rope. The ripping seam is like that of the spherical captive balloons. In free balloons the ripping slit can be wider toward the equator, and is cut out in the shape of a very

pointed triangle, which affords a quick deflation of the balloon. The base of the triangle must be smaller than the gores.

The length of the guide rope is calculated on the basis that for each 10 cu. m. capacity of the balloon 1 meter of guide rope must be allowed.

Mechanism. So that the ripping arrangement will be sure to work when landing, the ripping seam and guide rope must lie in the same meridian. The ring is to be placed on the running line, to bring the toggle for the guide rope under the ripping seam.

For ordinary equipment there must be:

One army blanket;
One guide rope;
Two pockets for maps, etc.;
One aneroid of 8000 meters; (free balloon ascension)
One thermometer;
One set of field maps;
One piece of rope of 25 meters length;
One clasp knife;
Two bags of confetti;
Five pieces of cord, 1 meter long;
Two packages containing 10 paper flags each;
Bags filled with sand according to the carrying capacity of the balloon.

After the end of the guide rope is fastened to the rope hoop of the ring, it is so attached to the car that it can be quickly let out. For this purpose the guide line is fastened in loops inside the car, the last loop hanging over the side of the car. During the adjustment of these ropes, the car

ropes of the side in question must be held up by one man, while another does the adjusting, so that no loop is placed over a car rope which would later prevent the letting out of the guide line.

If there is not enough room for the sand bags inside the car, they must be placed on the outside.

Preparations and the Ascension of a Free Balloon

Inflation. The inflation of a free balloon is similar to that of a spherical balloon.

In case it is desired that a high ascension be made directly from the ascension place, the balloon is to be inflated only to eight-tenths of its volume.

After the necessary inflation the appendix is to be connected by giving a strong tug on the knotted connections. During the coupling of the ring to the balloon care must be taken that the mooring rope (toggle) which serves for fastening the guide rope is fastened in the meridional plane of the ripping panel.

Attendance. The attendance for the free balloon is similar to that of the spherical, the arrangement of the crew being according to Fig. 39.

Ascension of a Free Balloon

The ascension of a free balloon is similar to that of a kite balloon, and is as follows:

1. Placing the equipped car of the free balloon on the ascension place, so that the guide rope is in the wind.

2. Placing the balloon over the car so that the ripping panel is in the wind.

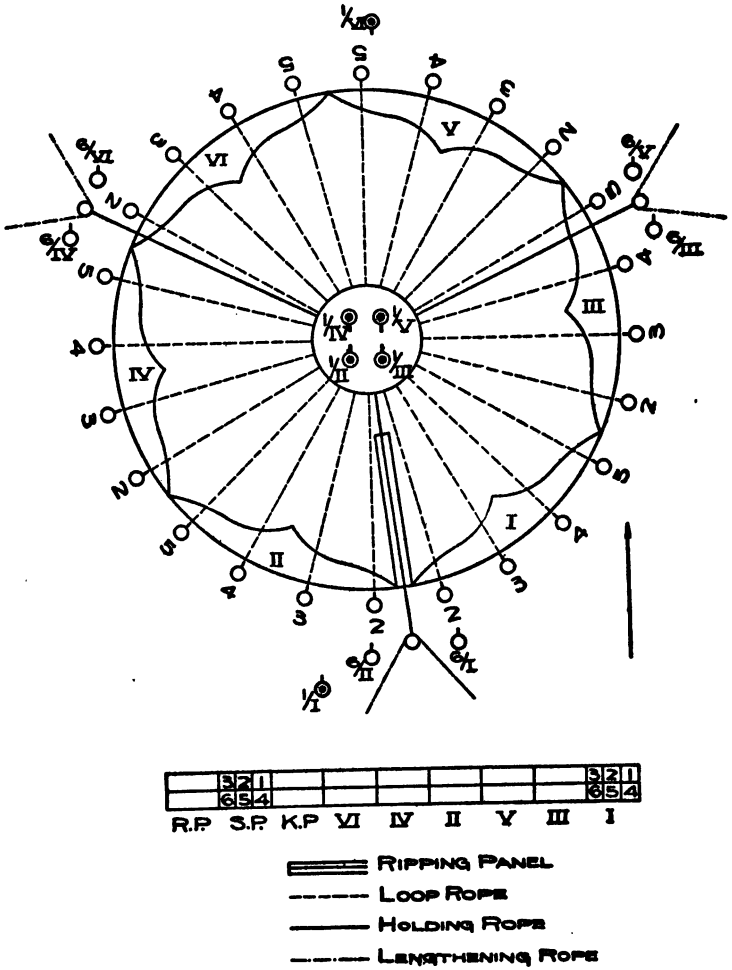


FIG. 39.—Attendance for Free Balloon.

3. Coupling the car onto the ring and the occupancy of the car.

4. Changing of the crew from the crow-foot lacings to the car ropes.

5. Laying out and lifting the balloon.

The activity of 1 to 4 is analogous to the spherical balloon, only in a free balloon the cars which are used have their car ropes of the same length, so that these do not cross.

During the changing of the men from the running rope to the ring, more men are demanded as the size of the ring increases. The rest of the crew are commanded by the balloon officer in charge to be at 50 paces distance from the balloon in the direction the balloon is going. Upon the command, "Up on the car ropes," ascension with the car cable takes place.

This must be done very carefully and the balloon must not rise rapidly. The speed of the ascension is regulated by the men stationed at the running ropes and at the car rim.

The weighing out serves the purpose of giving the balloon as little lifting power as possible. It is done in case of a moderate wind by taking off the lengthening ropes.

The withdrawing of the lengthening lines takes place on the command of "Let the lengthening line go."

All the commands of the balloon officer during the weighing out of the free balloon must be obeyed punctually by the car occupants.

In order to determine whether the balloon has any lifting power the men holding the car let it loose for a

moment upon the command of "Loose" and it is again seized and held fast upon the command of "Tight."

During the weighing out of the balloon, the car proceeds only until the balloon has the required lifting power, when, upon the command of "Open the appendix" the appendix is opened by a tug on the rope.

The pilot sees by looking into the balloon (rubber valve band) if the ropes are free and reports to the officer in charge: "Ropes are clear."

Then the balloon is let loose at the command of "Loose," while those numbers holding the car let go at the same time. During a strong wind, the free balloon is let loose with a measured lifting power. This is done by taking off several of the sand bags after the balloon has been lifted. In a free plain and during a moderate wind the balloon can be let up with its guide rope laid out. The latter is then laid in coils upon the ground in the direction of the flight.

In order to prevent the balloon from being pulled along the ground in case of wind during the ascension, the balloon, swinging in the direction of the wind, is to be let loose only that moment in which the swaying stops with the wind, and when the swaying has been renewed against the wind.

Should the balloon, upon the command of "Let go" start to drag, due to difficult or improper ascension, the men who are stationed there must hold the car.

FEB 2 1 1918

MILITARY BOOKS

A Short Title List of Standard Books on Military Science of All Publishers

D. VAN NOSTRAND COMPANY
Headquarters for
MILITARY BOOKS SINCE 1848
25 PARK PLACE NEW YORK

STANDARD MILITARY BOOKS

Detailed descriptions on request.

AERONAUTICS

BURLS, G. A.
Aero Engines $3.50

DIXIE, A. E.
Air Navigation for Flight Officers 4.00

DOMMETT, W. E.
Aeroplanes and Airships 80

DUCHENE, COMMANDANT
Flight Without Formulae 2.50

DUCHENE, COMMANDANT
The Mechanics of the Aeroplane 2.50

EIFFEL, G. (translated by J. C. HUNSACKER)
Resistance of Air and Aviation 10.00

FAGE, A.
The Aeroplane 2.50

GRAHAM-WHITE, C., and HARPER, H.
Learning to Fly 75

GREENHILL, G.
Dynamics of Mechanical Flight 2.50

HAYWARD, CHAS. B.
Building and Flying an Aeroplane 1.00

JUDGE, A. W.
Design of Aeroplanes 4.50

KENNEDY, R.
Flying Machines: Practice and Design . . . $2.00

KENNEDY, R.
Aeroplane Construction 1.50

LANCHESTER, F. W.
Flying Machines from an Engineering Standpoint 3.00

LANCHESTER, F. W.
Aerial Flight, 2 vols.
Vol. I —Aerodynamics 6.00
Vol. II—Aerodonetics 6.00

LANCHESTER, F. W.
Aircraft in War 4.00

LOENING, G. C.
Military Aeroplanes 4.75

MATTHEWS, R. B.
Aviation Pocket Book for 1917 . . . . . 1.50

PAGÉ, VICTOR W.
Aviation Chart; Power Plant Troubles Made Easy .50
Aviation Engines; Design, Construction, Repair 3.00
Glossary of Aviation Terms; English-French. Francais-Anglais 1.00

PIERCE, R. M.
Dictionary of Aviation 1.50

ROBSON, WILLIAM A.
Aircraft in War and Peace 1.00

SPAIGHT, J. M.
Aircraft in War 2.00

TALBOT, F. A.
Aeroplanes and Dirigibles of War 1.25

WIDMER, E. J.
Military Observation Balloons 3.00

WOODHOUSE, H.
Textbook of Military Aeronautics 6.00

ARTILLERY, COAST AND FIELD

Gunnery and Explosives for Field Artillery Officers .40

HAMMOND, J. S. and OLMSTEAD D.
Gunner's Handbook for Field Artillery 60
Manufacture of Artillery Ammunition . . . 6.00

HAVARD, V.
Military Hygiene $5.00

KEEFER, F. R.
Military Hygiene 1.50

LELEAN, P. S.
Sanitation in War 2.00

MUNSON, LIEUT. COL. EDW. L.
The Principles of Sanitary Tactics 2.00

MUNSON, E. L.
Soldier's Foot and Military Shoe. 1.35

STRAUB, PAUL F.,
Medical Service in Campaign 1.50

WOOD, R. C.
The Soldier's First Aid 50

WOODHULL, A. A.
Military Hygiene for officers of the Line . . . 1.50

LANGUAGES

Rapid-fire English-French-German for Soldiers . .25

COLEMAN and LA MESLÉE
Le Soldat Américain en France 50

CROSS, H.
Soldier's Spoken French 50

GULLICHAN, W. M.
Soldiers' English-French Conversation Book . .30

MORTON, MAJOR C. G.
English-Spanish Pocket Manual. Cloth . . . 1.00

MOSS, MAJOR JAS. A.
Spanish for Soldiers 1.00
Oxford English and French Conversation Book for Army and Navy Men 25

PICARD, J.
Cortina French-English Military Manual . . . 2.00

PLUMON, E.
Vade Mecum for the Use of Officers and Interpreters in the Present Campaign (French and English Technical and Military Terms) 75

WILKINS, COLEMAN and HUSE
First Lessons in Spoken French for Men in Military Service . . . . . $ .50

WILKINS, COLEMAN and PRESTON
First Lessons in Spoken French for Doctors and Nurses 50

MACHINE GUNS

AINSLIE, G. M.
Handbook on Rifle and Hand Grenades . . . 1.25

Combined Infantry and Cavalry Drill Regulations for Machine Gun Companies for Automatic Machine Rifle, Caliber .30 (Model 1909) 30

HATCHER, J. S., and others.
Machine Guns 2.50

Operation and Tactical Use of the Lewis Automatic Machine Rifle 60

LONGSTAFF AND ATTERIDGE
The Book of the Machine Gun 3.50

McKEDLAR, K. B.
Machine Gun Practice and Tactics 90

MERKATZ, F. v.
New Methods of Machine Gun Fire 25

SOLANO, E. J.
Machine Gun Training 1.00

MANUALS

UNITED STATES ARMY
Cavalry Drill Regulations 75

Field Service Regulations 75

Infantry Drill Regulations 50

Manual for Non-Commissioned Officers and Privates 50

Manual of Military Courts Martial 1.10

Manual of Interior Guard Duty 50

Small Arms Firing Manual 75

Rules of Land Warfare 75

Complete U. S. Infantry Guide (25 Government Manuals) 6.00

Shrapnel and Other War Material	$1.50
Coast Artillery Drill Regulations	1.00
Provisional Drill and Service Regulations for Field Artillery (Horse and Light)	1.25
Provisional Drill and Service Regulations for Field Artillery (6 Inch Howitzer), 1917	1.25
BETHELL, H. A.	
Modern Guns and Gunnery	6.00
BISHOP, H. G.	
Elements of Modern Field Artillery	1.50
BISHOP, H. G.	
Operation Orders, Field Artillery	1.00
CLOKE, H. E.	
Gunner's Examiner	1.50
DYER, A. B.	
Handbook of Light Artillery	3.00
EISSLER, M.	
Modern High Explosives	4.00
GRUBER, E. L.	
Notes on 3-inch Gun Material	.50
GUTTMAN, OSCAR	
The Manufacture of Explosives. 2 vols.	11.00
INGALLS, J. M.	
Interior Ballistics	3.00
LISSAK, O. M.	
Ordnance and Gunnery	6.00
MacALISTER, D. A.	
Field Gunnery	1.00
MARSHALL, A.	
Explosives. 2 vols.	16.00
MORETTI, O. and DANFORD, R. M.	
Notes on Training Field Artillery Details	2.00
OMMUNDSEN, H., and ROBINSON, E. H.	
Rifles and Ammunition	6.00
RUGGLES, C. L.	
Stresses in Wire Wrapped Guns and in Gun Carriages	3.00
SANFORD, P. G.	
Nitro-Explosives	4.00
SPAULDING, CAPT. OLIVER L.	
Notes on Field Artillery	1.25

WEAVER, E. M.
Notes on Military Explosives $3.00
WISE, T. C.
Gunnery; an Elementary Treatise 3.00
WORDEN, E. C.
Nitro-cellulose Industry. 2 vols. 10.00

FIELD ENGINEERING

Engineer's Field Manual 1.25
ARMY SERVICE SCHOOLS
Notes on Field Fortifications 50
BEACH, CAPT. WM. D.
Manual of Military Field Engineering. 9th Ed. Revised. Cloth 1.75
BOND, P. S.
Engineer in War 1.50
FIEBEGER, G. J.
Textbook of Field Fortifications 2.00
KENYON, R. E.
Land and Coast Fortification 2.00
ROBINSON, ERNEST F.
Military Preparedness and the Engineer . . . 1.50
SOLANO, E. J.
Field Entrenchments; Spadework for Riflemen . 1.00
VICKERS, L.
Training for the Trenches 1.00
WALDRON, W. H.
Elements of Trench Warfare 75

HYGIENE AND SANITATION

Drill Regulations and Service Manual for Sanitary Troops 75
Manual for the Medical Department, U. S. Army 1.10
ASHBURN, P. M.
Elements of Military Hygiene 1.50
HASTINGS, S.
First Aid for the Trenches 1.00

SUTHERLAND, S. J.
The Reserve Officers Handbook. Cloth . . . $1.25
Limp Leather 1.75

TURNER, G. S. and FULMER, J. J.
Battle Fire Training 1.00

WALDRON, W. H.
Company Administration 1.75

WELSHIMER, R. R.
Primer for the Officer's Reserve Corps and Officers of Volunteers and the National Guard 1.00

PHYSICAL TRAINING

Handbook of Physical Training. 2 vols. (English)
Vol. I 50
Vol. II 50

BUTTS, E. L.
Manual of Physical Drill 1.25

GAREY, E. B.
Manual of Physical Drill 1.00
Manual of Physical Training, U. S. Army 75

SCIENCE OF WAR

ALTHAM, E. A.
Principles of War. 2 vols. 4.50

AZAN, P.
War of Positions 1.25

FLETCHER-VANE, FRANCIS
The Principles of Military Art 1.25

HENDERSON, COL. G. F. R.
The Science of War 4.00

SARGENT, COL. H. H.
Campaign of Santiago de Cuba. 3 vols. 5.00

SARGENT, COL. H. H.
Campaign of Marengo 1.50

SARGENT, COL. H. H.
Napoleon Bonaparte's First Campaign . . . 1.50

VON CAEMMERER
Development of Strategical Science during 19th Century $3.00

VON CLAUSEWITZ, GEN. CARL.
On War. 3 vols. 7.50

VON DER GOLTZ, LIEUT.-GEN.
The Conduct of War 2.00

SIGNALLING

Manual of Electric Instruments and Telephone for the Signal Corps 1.00

Drill Regulations for Field Company of the Signal Corps 75

JOLY, J.
Synchronous Signalling in Navigation 75

PALEN, M. A.
Lessons in Visual Signalling 60
Signal Book, U. S. Army 35

STEVENS, E. J.
Field Telephones for Army Use 1.00

ZENNECK, J.
Wireless Telegraphy 4.00

TACTICS

Tactics of Coast Defence 2.00

ARMY SERVICE SCHOOLS
Studies in Minor Tactics 75

BALCK (COL.) Translated by Walter Kreuger
Tactics
Vol. I—Introduction and Formal Tactics of Infantry 3.00
Vol. II—Cavalry, Field and Heavy Artillery in Field Warfare 3.00

BOND, P. S., and McDONOUGH, M. J.
The Technique of Modern Tactics 2.65

BJORNSTAD, A. W.
Small Problems for Infantry 75

ANDREWS, L. C., and others
Fundamentals of Military Service $1.50

Bayonet Training Manual, Used by the British Forces 30

BOLLES, F. C. and others
What a Soldier Should Know 1.00

FITSCHEN, H.
Spade (Trench) Warfare. Trans. from German. .50

KILNER, W. G. and MACELROY, A. J.
The Cantonment Manual 1.00

DONOVAN, T. F.
Home Guard Manual 50

GUILD AND TEST
Militia Field Manual 1.00

HOLBROOK, L. R.
Mess Officers' Assistant 1.00

HOLBROOK, L. R.
Mess Sergeant's Handbook 1.00

LAWTON, MAJOR F. H.
Extracts from U. S. Army Regulations 1.00

McARTHUR, J. C.
What a Company Officer Must Know 2.00

MOSS, J. A.
Army Paperwork 2.00

MOSS, MAJOR JAS. A.
Infantry Drill Regulations (with annotations) . .75

MOSS, MAJOR JAS. A.
Non-commissioned Officers' Manual 1.50

MOSS, MAJOR JAS A.
Officers' Manual 2.50

MOSS, MAJOR JAS. A.
Privates' Manual 1.00

ROBBINS, E. J.
Universal Drill Manual 1.00

SELKIRK, W. O.
Catechism of Manual of Guard Duty 50

SOLANO, E. J.
Musketry 1.00

SPINELLI, MAJOR H. B.
A Catechism of Court-Martial Duty. 75

TURNER, F. H.
Infantry Drill Regulations, Annotated . . . . $ .75

TUPES, H., and POOLE, S.
Manual of Bayonet Exercises and Musketry Fencing 50

WILLIAMS, A. E.
Manual for Quartermasters 1.10

WILLIAMS, A. E.
Company Supply Manual—Infantry 40

MILITARY TRAINING

BROCKINGTON, W. A.
Elements of Military Education 1.50

BADEN-POWELL, R.
Quick Training for War 50

CAMPBELL, M. V.
Rapid Training of Recruits 1.00

ELLIS, E. O., and GARY, E. B.
The Plattsburg Manual. A Textbook for Military Training Camp 2.00

GAREY E. B. and ELLIS, O. O.
The Junior Plattsburg Manual 1.50

HAKING, BRIG. GEN.
Company Training 1.50

LAFFARGUE, ANDRE
The Attack in Trench Warfare 50

MORRISON, JOHN F.
Training Infantry 60

MOSS, JAS. A.
Manual of Military Training 2.25

MOSS, JAS. A.
Questions on Manual of Military Training . . .50

MOSS, JAS. A.
Self-Helps for the Citizen-Soldier 2.25

PARKER, JOHN H.
Trained Citizen-Soldiery 1.25

SOLANO, E. J.
Drill and Field Training-Scouting 1.00

STACEY, C.
Company Training 1.00

Manual for Army Bakers	$ .50
Manual for Army Cooks	.75
BAKER, C. B. **Transportation of Troops and Materiel**	1.50
BAKER, C. B. **Handbook of Transportation by Rail and Commercial Vessels**	1.00
BAKER, I. O. **Roads and Pavements**	4.50
ESPANET, OCTAVE **Notes on the Supply of an Army**	1.50
HOLBROOK, L. R. **Handling the Straight Army Ration**	1.50
LAWTON, F. H. and others **Field Quartermaster's Handbook**	2.00
LAYRIZ, O. **Mechanical Traction in War for Road Transport.**	2.00
WEBB, W. L. **Railroad Construction**	4.00
WIMPERIS, H. E. **Principles of the Application of Power to Road Transport**	1.50

MISCELLANEOUS

Army and Navy Diary	.50
BAKER, I. O **Masonry Construction**	4.50
BAKER, M. N. **Potable Water and Methods of Detecting Impurities**	.50
BARNES, J. B. **Letters of a Plattsburg Patriot (humorous)**	1.00
BUNKLEY, J. W. **Military and Naval Recognition Book**	1.00
CAMERON, L. C. J. R. **Infantry Scouting**	1.00
CARTER **Horses, Saddles and Bridles**	2.75
CLOKE, H. E. **The Enlisted Specialist's Examiner**	2.00

DAVIS, G. B.
The Elements of Law **$2.50**

DAVIS, G. B.
A Treatise on the Military Law of the United States **7.00**

DION, S. A.
Tanks, Gas, Bombing, Liquid Fire **1.25**

DUDLEY, E. S.
Military Law and the Procedure of Courts Martial **2.50**

FALLS, D. W. C.
Army and Navy Information **1.00**

FIEBEGER, G. J.
Civil Engineering **5.00**

FOSTER, H. A.
Electrical Engineer's Pocket-book **5.00**

FRYE, A. I.
Civil Engineer's Pocket-book **5.00**

GRUBER, E. L.
Notes on 3-inch Gun Material . . . . . **.50**

HENDERSON, D.
Art of Reconnaissance **1.50**

HOWE, G.
Mathematics for the Practical Man **1.25**

KENT, W.
Mechanical Engineer's Pocket-book **5.00**

LALLIER, E. V.
Elementary Manual of the Steam Engine . . **2.00**

LAWTON, F. W., and DEMPSEY, W. A.
Quartermaster Administration **2.00**

LODGE, O. J.
Elementary Mechanics **1.50**

MACQUARRIE, HECTOR
How to Live at the Front **1.25**

McKENNEY, H. J.
Exercises for Systematic Scout Instruction . . **1.25**

MARSHALL
Elements of Hippology **1.50**

MERRIMAN, M.
Treatise on Hydraulics **4.00**

GRAY, ALONZO
Cavalry Tactics $1.00

GRIEPENKERL, MAJOR GENERAL
Letters on Applied Tactics 2.00

HANNA, M. E.
Tactical Principles and Problems 2.50

HOENIG, FRITZ
Inquiries into the Tactics of the Future . . . 2.00

INGALL, J. M.
Handbook of Problems in Direct Fire 4.00

LAFFARGUE, A.
Attack in Trench Warfare 50

MAGUIRE, E.
Attack and Defense of Coast Fortifications . . 2.50

MERCUR, JAMES
Attack of Fortified Places 2.00

MOSS, JAS. A.
Applied Minor Tactics 1.00

MOSS, J. A.
Trench Warfare 1.25

NICHOLSON, W. A.
Artillery Fire 1.50

SMITH, J. S.
Trench Warfare 1.50

SWINTON, E. D.
Defense of Duffer's Drift 25

THUILLIER, CAPT. H. F.
The Principles of Land Defence 5.00

VON ALTEN
Studies in Applied Tactics 2.00

WAGNER, A. L.
Strategy 75

WISSER, JOHN P.
Practical Field Exercises in Tactics and Strategy. Cloth 2.00

WALDRON, W. H.
Tactical Walks 1.50

TOPOGRAPHY

BARNES, CAPT. JOHN B.
Elements of Military Sketching and Map Reading $ .75

CARLOCK, F. D.
Military Topography and Photography . . . 2.50

COLE, E. F.
Individual and Combined Sketching 1.00

GRIEVES, L. C.
Military Sketching and Map Reading 1.00

GRIEVES, L. C.
Military Sketching and Map Reading for Non-Commissioned Officers 1.25

LAFFARGUE, ANDRE
The Attack in Trench Warfare 50

MERTENS, translated by W. KRUGER
Tactics and Technique of River Crossings . . 2.50

REED, H. A.
Topographical Drawing and Sketching . . . 4.00

REINHARDT, C. W.
Lettering for Draughtsmen, Engineers, and Students 1.00

SHERRILL, C. O.
Military Map Reading 90

SHERRILL, C. O.
Military Topography 2.50

SHERRILL, C. O.
Rapid Reconnaissance Sketching 1.25

SMITH, R. S. and McMILLAN, C.
Manual of Topographical Drawing 2.25

SWEENEY, W. C.
Sketching Methods 1.00

WILSON, H. M.
Topographic Surveying 3.50

TRANSPORTATION AND RATIONING

Army Horse in Accident and Disease (1909)
Mounted Service School 85

Army Transport Service Regulations 50

VAN NOSTRAND'S MILITARY MANUALS

72 Pages Illustrated 3⅝ x 5⅛ Postpaid 30c.

Baynet Training Manual

Used by the

BRITISH FORCES

The material in this book is from the latest British Training Manual (1916), which is based on their experience, and their forces as well as ours are now being trained in accordance therewith.

The methods described have been adopted for use in training the United States forces.

150 Pages Illustrated 3 Folding Plates 3⅝ x 5⅛ Postpaid 60c.

Operation and Tactical Use of the

Lewis Automatic Machine Rifle

Based on the Experience of the European War

With an Introduction by the Inventor **Col. I. N. LEWIS, U.S.A.**

The descriptive text is full and accurate in detail, while the system of preliminary and practical field instruction as outlined follows closely that now employed at the various machine gun schools and special instruction camps in England, France and the United States.

90 Pages Illustrated 5 Folding Plates 3⅝ x 5⅛ Postpaid 50c.

The Attack in Trench Warfare

By Capt. ANDRÉ LAFFARGUE

153rd Infantry, French Army

Translated by an Officer of Infantry

A careful study on the general and detailed aspects of the tactics of the attack in trench warfare, one of the important features of which is a study of the methods of training infantry units for this class of military operations. General Joffre was so impressed with the value of this book that he had it published to the French Army before giving it out for general publication.

VAN NOSTRAND'S MILITARY BOOKS

275 Pages 105 Illustrations 4 Folding Plates 6 x 9 Postpaid $2.50

TACTICS AND TECHNIQUE OF RIVER CROSSINGS

BY

COLONEL MERTENS

TRANSLATED FROM THE GERMAN BY

WALTER KRUEGER

Major U. S. Army

Presents a carefully thought out scheme of a way in which river crossings may be effected and of how the attacker, once across, may be met.

157 Pages 40 Illustrations 3 Plates 5 x 7 Cloth Postpaid $3.00

MILITARY OBSERVATION BALLOONS

(CAPTIVE AND FREE)

A complete treatise on their manufacture, equipment, inspection, and handling, with special instructions for the training of a field balloon company

BY

EMIL J. WIDMER

This book is based on the Balloon Manual of the German army, including drill and equipment used at the beginning of the present war.

MOSS, MAJOR JAS. A.
Peace and War Duties of the Enlisted Man . . $ .50

MOSS, MAJOR JAS. A. and WALDRON, MAJOR W. H.
What Sammy's Doing 75

PARKER, P. A. M.
Control of Water 5.00

PARKER, RALPH M.
An Officer's Notes 2.00

REY, JEAN (Trans. by J. H. JOHNSON)
Range of Electric Searchlight Projectors . . . 4.50

ROBINSON, LIEUT. COL. W.
Electricity 2.50

SOLANO, E. J.
Camps, Billets and Cooking 1.00
The Soldiers' Diary and Note Book 1.00

STEWART, M. B.
Military Character, Habit, Deportment, Courtesy and Discipline 1.00

SWOOPE, C. W.
Lessons in Practical Electricity 2.00

TURNER G. S. and FULMER J. J.
Battle Fire Training 1.00

WALDRON, W. H.
Scouting and Patrolling 25

WALSH, H. P.
Taking Bearings 1.00

WIMPERIS, H. E.
Primer of the Internal Combustion Engine . . . 1.00

ZU HOHENLOHE INGELFINGEN, PRINCE KRAFT
Letters on Infantry 2.00

ZU HOHENLOHE INGELFINGEN, PRINCE KRAFT
Letters on Cavalry 1.75

ZU HOHENLOHE INGELFINGEN, PRINCE KRAFT
Letters on Artillery 2.50

THE WALDRON BOOKS

By Major WILLIAM H. WALDRON, 29th U. S. Infantry

SCOUTING AND PATROLLING

Cloth Bound -:- Fits the Pocket

WHAT TO DO—HOW TO DO IT

Covers the duties of the individual scout and the operations of the Patrol in *"No Man's Land."*

Postpaid - - - 50c.

Elements of TRENCH WARFARE

Cloth Bound -:- Fits the Pocket

Compiled from the latest information of how they are going about it on the Western front.

Profusely illustrated.

Postpaid - - - 75c.

COMPANY ADMINISTRATION

A reference book that no Company Commander, First Sergeant or Company Clerk can afford to be without. The most complete and practical treatment of the subject that has been produced.

Postpaid - - - $1.25

TACTICAL WALKS

A system of instruction for Officers and non-commissioned Officers for the duties that will devolve upon them in actual service. No glittering generalities—a book of detail—just what to do. Written so you can understand it.

Postpaid - - - $1.50

The Infantry SOLDIER'S HAND-BOOK

An illustrated text-book covering the training of the infantry soldier for war.

Every soldier in the Army should have a copy.

Postpaid - - - $1.00

VAN NOSTRAND'S MILITARY BOOKS

THIRD EDITION

125 Pages Illustrated 5 Folding Plates 4½x5¾ Cloth Postpaid 75c.

ELEMENTS OF MILITARY SKETCHING AND MAP READING

BY

JOHN B. BARNES

Major Barnes' book is based on an expert knowledge of the subject as taught by the Service Schools, Fort Leavenworth, and an appreciation of the needs of beginners through his wide experience as an instructor of National Guard Officers, and at Officers' Training Camps.

Written with a view of self-instruction, with new and original illustrations that explain simply and graphically the points that are usually found troublesome by beginners.

The new and important subject of **Landscape Sketching** is thoroughly explained and illustrated.

Map reading is explained in a few pages. Scales are already constructed.

Pocket size, so it can be carried along conveniently.

VAN NOSTRAND'S MILITARY BOOKS

231 Pages 51 Plates—Many in Colors Pocket Size Price $1.00

MILITARY and NAVAL RECOGNITION BOOK

A handbook on the organization, insignia of rank, and customs of the service of the World's Important Armies and Navies.

BY

Lieut. J. W. BUNKLEY
U. S. Navy

A complete, correct and fully illustrated guide to the insignia of our army and navy as well as of those of the nations engaged in the war, compiled from official sources and useful alike to civilians as well as to the Army and Navy.

You will need this book to help you recognize our boys at home and to distinguish the other boys "over there."

D. VAN NOSTRAND COMPANY

HEADQUARTERS SINCE 1860
for
MILITARY AND NAVAL BOOKS
25 Park Place *NEW YORK*

UNIVERSITY OF MICHIGAN
3 9015 04888 9086